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LITERARY CONTENTS.

	Page.
LEADERS	195-200
Economic Aspects of Admiralty Contracts ...	195
Standardisation of Electric Supply Mains ...	197
A Plea for Kew Observatory	198
Another British Defeat due to Negligence ...	199
Improvements on American Methods	200
EDITORIAL OPINION	201-204
ARTICLES Specially Contributed by the World's Experts	205-264
Thermal Efficiency of Steam Engines. W. D. Wansbrough	205
Midland Railway Enterprise. C. E. Allen, A.I.Mech.E.	212
Power Hammers. E. Samuelson, M.Inst.C.E., M.I.Mech.E.	233
Gold-Mining Machinery. Philip R. Björling	243
British Commercial Supremacy. Ernest D. Phillips	258
MACHINERY APPLIANCES AND PROCESSES ...	265-275
Reopening of some Early Roman Copper and Lead Mines in Tuscany	265
Wright's Patent Taper Roller Bearings ...	268
An Improved Motor Controlling Switch ...	270
A New Marine Torch	271
800-I.H.P. Compound Vertical Electric Traction Engine	272
A 1000-Kilo-watt Steam Turbine and Alternator	272
WORKSHOP PRACTICE...	276-279
INDUSTRIAL PROGRESS	280-282
THE WORLD'S INDUSTRIAL ENGINEERING PRESS	283-289
REVIEWS	290-296

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FEILDEN'S MAGAZINE.

19th Issue. FEBRUARY, 1901. Vol. 4. No. 2.

Economic Aspects of Admiralty Contracts.

APART altogether from the comparative merits of the work done in Government dockyards and in private shipyards, and also from the argument that the Government establishments should never be so full of construction work as to potentially cripple their value for repair work in the event of an unexpected war with a naval power, the placing of contracts by the Admiralty with private firms has important economic aspects. There is, of course, that greatest of all considerations—the enlarging of the sources of supply so that we may not in time of need, or, indeed, at any time, be too dependent on limited instruments. There is, next, the widening of the area of employment in the production of the highest types of naval architecture and of machinery, whereby the highest skilled labour is distributed with its educational influence throughout the country, instead of being concentrated in Government establishments more or less swaddled in red tape. There is, further, the fructifying investment of capital in equipping and maintaining private shipyards and engine-shops up to the Admiralty standard. And there is, lastly, the wholesome and stimulating circulation of money in the payment of wages and material in various parts of the country.

Whether warship building is profitable work or not for private undertakers is beside the question. We may rest assured that it is not altogether a question of machinery or of workshop arrangement: that essential conditions are certainly experience and diplomacy. And it is fair to assume that if all the advantages of Admiralty work cannot be expressed in terms of £ *s. d.* on the credit side of profit and loss account, they may be found in the prestige and power it gives to a firm. As a rule, probably more profit is got out of warships built for foreign Governments than out of those built for our own Navy. This, honest Britons will think, is as it should be. But the principal builders of warships for foreigners are the Elswick Co., and as they also supply the ordnance, nobody knows whether they make their profit out of the ships or out of the guns.

How great an industry warship building is may not be generally known. In the year 1899 British shipbuilders (not the Government Dockyards) launched 29 warships of a total tonnage of 101,690 tons displacement. Of these 12, of 54,240 tons, were for the British Navy, and 17, of 47,450 tons, were for various foreign navies. In addition, there were six warships launched at the Government dockyards, of an aggregate tonnage of 66,900 tons. Now these six vessels, according to the amount voted for them, cost on the average £75 per ton, or some £12 10*s.* per ton more than the 1898 average cost, owing to the superior quality and higher prices of the material used. The 54,240 tons built for the Admiralty in private yards included some smaller and lighter vessels, but, taking the average at £70 per ton, they represented upwards of three-and-three-quarter millions of money distributed for wages and materials. The work done for foreign navies cannot be taken at a lower average, as it included battleships and heavy armoured cruisers of high speed. Therefore the new warships launched in the United Kingdom in 1899 represented a total of from £13,000,000 to £15,000,000 sterling, of which all save about £5,000,000 passed through the

hands of private builders. This is big business.

At the end of September last there were 56 warships of a total displacement of 262,045 tons "under construction" in private yards. This, on an average of £70 per ton, represents a value of considerably over 18 millions, but "under construction," in the terms of Lloyd's returns, includes vessels at all stages until they finally leave the builders' hands, and in the 262,045 tons will be included much of the tonnage launched in 1899 and valued above. Still, allowing for this, it will be seen that there is a vast amount of warship work on hand, but for which shipbuilding would have been in a much more languishing condition than it was when a little spurt of orders for merchant vessels began in July last.

To this work has been added the contracts for four armoured cruisers, let out by the Admiralty at the end of October. Three of these are to be built on the Clyde, where, at the time when the contracts were allotted, the following warship work was already on hand :—

Yards.	Description.	Tons Displacement.
Clydebank ...	3 armoured cruisers	38,100
Glasgow ...	1 ,, cruiser.	9,800
Govan ...	3 ,, cruisers	36,400
Clydebank ...	4 destroyers ...	1,288
Govan ...	1 destroyer ...	322
	12	85,910

The three new cruisers will add about 30,000 tons (including the expenditure of 1½ million of money) to the warship work on the Clyde, and this means an enormous help to the industries of that busy shipbuilding and engineering centre.

The distribution of money in this case, however, does not altogether correspond with the allocation of tonnage. The three Clyde contractors are the Fairfield Co., £516,500 (including £220,000 for the engines); the London and Glasgow Shipbuilding and Engineering Co., £527,000 (including £227,000 for the engines); and Messrs. William Beardmore & Co., £517,000 (including £222,000 for the engines). But Messrs. Beardmore are not to supply the engines for the cruiser they build. This seems strange, for they have acquired the shipbuilding yard and engineering establishment so long carried on by the famous firm of Messrs. Robert Napier & Sons, Govan, who at one time got all the Admiralty work that went to the Clyde; but the engine-shop of the new firm is not yet on the Admiralty list, although the shipyard is, and therefore the contract for the engines for the Beardmore cruiser has been placed with Messrs. Humphreys, Tennant & Co., London. On the other hand, Messrs. Beardmore will make their own armour-plates, money for which will, therefore, be spent in the district, whilst the plates for the two other cruisers will have to be brought from Sheffield, or elsewhere. The fourth cruiser is to be supplied by the Armstrong-Whitworth Co. at Elswick, who now make their own armour-plates, but who are not marine engineers.

The closeness of the Clyde tenders is indicative of the long experience of the builders there, which enables them to "cut it fine." All the English tenders were considerably higher, and the order given to the Elswick Co. is said to be for the purpose of testing the resources of that establishment in the matter of rapidity of construction. The Clydebank Co. (John Brown & Co., Ltd.) and the Barrow Co. (Vickers, Sons & Maxim, Ltd.) were not asked to tender for these cruisers, as the naval authorities were good enough to think they have as much work on hand as they can manage.

It becomes a question whether in connection with work of an urgent character for the State—and all naval work is really urgent—employers should not be endowed with some special powers over their men. To what dangers a single trade union may expose the country we had a fair illustration of in the case of the great engineering strike of 1897-98. The resources of our private shipyards are, we are convinced, more than ample for all the needs that can ever arise for naval purposes; and the production of armour-plates (now about 40,000 tons per annum, and equal to the equipment of a dozen vessels a year) can be increased by exist-

ing makers to almost any extent on reasonable notice being given. But the Labour drag keeps down our power of warship production very seriously, and the sooner the country realises this fact the better, for the day is coming when it will call for legislative action.

Meanwhile, we favour the widest distribution of Government-work in times of calm, so as to have the largest possible amount of experience at disposal in times of disturbance. Not every shipbuilder, however skilful in other respects, can build a battle-ship or swift armoured cruiser, and in the matter of naval contracts more delay may occur through inexperience than through material. This is why the Admiralty should always seek to extend and not to contract their list. It is, indeed, a question whether it would not be cheaper and better for the country to give out all naval construction on contract (under strict State regulations as to labour) and to keep the Dockyards entirely free for repair work, which must increase year by year with the size of the fleet.

Standardisation of Electric Supply Mains.

In a leader which appeared in this Magazine in April last we called the attention of our readers to a paper by Mr. R. Percy Sellon on the Standardisation of Electric Plant, and expressed our fullest approval of the effort he was making to rouse manufacturers to active steps towards the abolition of the present chaos in specifications for electric plant.

A definite and important step in this direction has now been taken by eleven firms, which include all our principal makers of electric cables.

These firms have formed themselves into "The Cable Makers' Association," with offices at 2, Queen Anne's Gate, Westminster, and with Mr. A. H. Howard as honorary secretary, and as such have issued to consulting engineers a letter covering a circular setting forth the terms and conditions which they suggest as a basis for future tenders, and a table of electric supply mains, which will form the standard sizes manufactured by the firms included in the Association after the first day of the present month. To use the words of the letter—"It is believed that the adoption of these terms and standards will act equally for the benefit of the purchaser and the manufacturer, and they are forwarded to you in the hope that you will be willing to adopt them in any specifications you may be preparing."

It should be unnecessary to comment on the advantage of standardised sizes of cables. It is, however, a common practice among consulting engineers to specify the copper portions of electric cables in terms of square inches of cross section. This does not specify the conductivity with close accuracy, even when the specific conductivity of the copper to be used is definitely stated, as the conductivity of a cable depends to a very appreciable extent on the stranding. The calculation of the most economical conductivity rests, moreover, in the great majority of cases, on data which can only be approximate, if not largely conjectural. In spite of this many engineers will insist on the contractors adhering so closely to their specification, that cables have to be specially made, whereas the cable makers if allowed a free hand would be able to supply a cable of slightly higher conductivity at a price actually lower than they can quote for the specially manufactured one.

The suggestions which follow the proposal to specify these standards are also of very considerable importance. They have evidently been very carefully considered, and appear to be fairly drawn, with a view of defining exactly the liabilities of the contractor, without leaving him open to suffer loss through the actions of persons over whom he has no control, or placing him entirely at the mercy of the engineer.

There is no doubt that a tendency has been shown in many cases, especially

where the consultant has had but little experience, and is very probably unduly anxious to please his clients, to draw engineering specifications in such a manner as to make it quite possible for the contractor to be very severely mulcted without having in any way deserved it. This is unsatisfactory in every way, and should be rigidly guarded against.

Municipal councillors are not always men of broad intelligence, and there may therefore be found among them men who will consider their consulting engineer a very clever man if he has drawn his specification in such a manner as to place the contractor practically at their mercy. They have no intention, in the majority of cases, of acting unfairly, but the sense of power pleases them. Would they be quite so well pleased if they could see a little further, and realise the price they are paying for a right which they have no intention of exercising, and which, if they did exercise it, would be of no benefit to them?

In very bad cases the result is to prevent first-class firms from tendering at all, the only firms who will tender being those who will incur any risk for the sake of getting work, trusting to the inexperience or incapacity of the engineer to enable them to smuggle through inferior material and worse workmanship. Extreme cases like this are not frequent, but what does happen very often is that the tenders from responsible firms are very appreciably higher than they would otherwise have been, the addition to the price being simply a payment to the contractor for the risk which he runs of incurring loss independently of any default on his part. The business-like principle is that the contractor should be made responsible for his own shortcomings, and not for other people's defaults or whims; and this appears to be the trend of the suggestions made by the Cable-makers' Association. We trust they will receive the attention they deserve. We wish the Association success, and we trust that others may be found to do the same good work in other directions, in some of which, however, the difficulties to be overcome are very much greater than in the present case.

A Plea for Kew Observatory.

JUDGING from the average character of the communications sent to the daily press by the typical newspaper reader with reference to the question whether the claims of the authorities of Kew Observatory should have precedence over the demands of "the man in the street" clamouring for greater comfort and superior travelling facilities, the British public requires some education as regards the value of scientific research; and our daily contemporaries will fail in their duty if they omit to point out to their readers that they are lamentably in error, and do not know their own interests, when they treat with indifference the work done at Kew, and object to some slight sacrifice in order to maintain the conditions necessary for the continuance of such work. We will leave aside, for the moment, the question whether or not some compromise could not be found by which the public might secure its electric lines and the meteorological observations still be continued without being interfered with by the electric currents—though it must not be imagined that a transference of the Observatory to some other locality is a simple way out of the difficulty. What we desire to make clear at present is the fact that, if there should be no other alternative than either to sacrifice the Observatory or the electric traffic passing so near to it as to interfere with the accuracy of the observations, the interests of the public would be far better served by abandoning the electric tramway lines in the neighbourhood than by destroying the efficiency of this scientific institution. The study of terrestrial magnetism—one of the chief subjects of research carried on at Kew, which is the central meteorological observatory of the United Kingdom—is of the utmost importance for modern navigation; and, since Britannia's rule of the waves is the essence of her power, let us not forget that to maintain this rule nowadays requires more than the pluck and endurance of our sailors; for naval, like military, success is becoming more

and more dependent upon thorough knowledge and careful application of the laws of science. Even in former ages those who knew the variations of the compass had an advantage over those who took for granted the infallibility of the needle. After the advent, however, of the iron and steel vessel, the sailor's reckonings would have been sadly at fault had not scientific research taught him that the magnetic earth currents transform his ship into a very unstable magnet, affecting the readings of the compass and reducing the value of the direction given by the polarity of the earth in a very appreciable degree. It is due entirely to such investigations as are being pursued at Kew that the problem of rendering correct the reading of the compass under such circumstances has been solved, and that, even at the speed which steam power has given to vessels crossing the wide expanse of ocean, the navigator has been able to calculate the direction of his course, and will be able to do so, however much this speed increases. Charts of magnetic declination, corrected up to date, are indispensable to modern navigation; and it is upon the work carried on in observatories such as that of Kew that such charts are based; for only in the meteorological stations can the research be pursued that will ultimately supply us with a reliable theory of terrestrial magnetism, which is an important desideratum for a nation which aspires to maintain the foremost rank in ocean traffic. Nothing, therefore, can be more near-sighted than to ignore the importance of scientific research as those ignore it who demand that Kew Observatory should be sacrificed to the ephemeral requirements of local traffic.

Another British Defeat due to Negligence.

The British public cannot accuse the press of our country of having been remiss in the duty of warning their readers that of late we have been losing ground in the competition for industrial supremacy, and that this ground is being swiftly occupied by new comers in the field of civilisation. If this were due entirely to unavoidable circumstances—as in a few cases it undoubtedly is—the wisest course would be to resign ourselves to the changed condition of things, and to confine our exertions to the maintenance of what we still possess rather than making vain efforts to recover what is no longer ours. In the majority of instances, however, this is not the case, and our defeat is due, not to the advantages possessed by our competitors, but to our own criminal indifference and our deplorable blindness, which does not permit us to distinguish between what is essential and what is contingent for the purpose of occupying a leading position among modern nations. At the risk, therefore, of being accused of tiresome reiteration, we must repeat what we have above illustrated by a practical example, that, as a nation, we have been guilty in recent times of underrating the importance of scientific research, and shown a tendency to sacrifice for temporary comfort the very means by which such comfort has been secured. The wonderful changes in the social conditions of mankind that are the very symbol of the century just completed are, almost without exception, due to the scientific achievements of the great students of physical science, who devoted their life to the discovery of the laws of the material world, and of whom no small portion was born on British soil. The utilisation of their discoveries, though an achievement of lesser import, has made a far greater impression upon the general public than the work of those who constructed the solid basis upon which modern civilisation rests. Like the thoughtless boy of an ancient legend, who, after receiving the key that secured him admission to the mountain grotto hiding priceless treasures, filled his apron with the glittering wealth of gold and precious stones, but, in his eagerness, left the key behind, and, after having squandered his riches, found that he could no more return to the place and secure a new supply, we may awake one day to find too late that in our greedy desire to reap material benefits from the treasures that have been rendered accessible to us through the key of science, we have lost

that key itself, and have sacrificed the permanent for the transitory. Lest the reader should imagine that we are too pessimistic in our presentiment, we will draw his attention to the following words contained in an admirable publication, distributed gratis during the Paris Exhibition to all who evinced a desire of studying the splendid joint exhibit of German mechanicians and opticians, consisting of scientific instruments of precision :—

"At the commencement of the nineteenth century the French and English makers of scientific instruments were far in advance of the Germans. True the eighteenth century knew of prominent mechanicians . . . yet the French and English makers took the lead, so as almost to supply the world's entire demand in scientific instruments. This predominance had the further consequence of causing young Germans to emigrate to France or England in order to thoroughly master their subject. Many a German mechanic of to-day owes to French and English masters a substantial portion of his knowledge. . . . In Germany it is only within the last twenty or twenty-five years that the State has espoused the interests of the home industry in scientific instruments; but such have been the efforts and the results that her position has, at a blow as it were, changed in favour of Germany."

This statement is supported in another portion of the publication—which consists of an excellent descriptive catalogue prepared by the German Association of Mechanicians and Opticians, with the aid of the authorities of the "Reichsanstalt" and the Standardising Committee—by an account of the growth of this industry, from which it appears that during the last ten years the annual total of the instruments exported has increased in value from £200,000 to more than £700,000. All scientists who have seen the exhibit of scientific instruments to which this refers agree that it was admirable in every way, and clearly demonstrated the fact that Germany in this branch of mechanics is far in advance at present of all her competitors, and has obtained a position which will most likely be strengthened from year to year. And yet, in the beginning of the nineteenth century England shared with France the honour of occupying a pre-eminence so great that it seemed almost impossible that she would ever lose it. *Sapienti sat!*

Improvements on American Methods.

It has been admitted by us, and, in fact, cannot but be admitted, that in electrical engineering the United States have stolen a march, and moreover a rather long march, upon us. For some time to come, at all events, their position in the front rank will remain unassailable. Still, that ought not to prevent us—if we needs must import their electric traction equipment and imitate their methods—from securing what is best among their material, and from imitating what is most successful. We quite agree with the author of a recent contribution to *Nature*, that the question of stray currents—which threaten to cause serious damage to the gas and water pipes of the Metropolis—is one of great importance, and will become still more important when the numerous projects for additional electric lines begin to take a practical form. It is true, no doubt, that a double overhead line of isolated conductors is in certain cases impracticable; still, our electrical engineers should be able to devise some other means of avoiding serious damage to other interests, be they, as in the case of Kew Observatory, those of scientific research, or, as in the majority of other cases, those of the shareholders of gas and water companies. Economy will always remain a powerful factor in a new enterprise, and it should be remembered that vast sums wasted by aimless experiments can be saved by a comparatively small amount invested in scientific research. In the United States, where the rule of thumb still prevails in experiments in which sound scientific knowledge alone should lead the way, the existing conditions are of a nature that render the consequences of such wasteful methods less injurious; but in Europe, where the struggle for existence is rendered more arduous owing to over-population and the limited natural resources, economy is of more vital consideration, and nothing is more certain to result in economy than a liberal expenditure for the purpose of scientific research.

SUP

Photo. by Russell & Sons, London.

"She wrought her people
lasting good."

Tennyson.

Victoria R.I.

The Great, Good Queen.

1837-1901.

THE MOST GLORIOUS REIGN IN HISTORY.

ALL through the early hours of June 20th, 1837, two messengers were hurrying from Windsor to London. The soft air of that summer morning was broken only by the twittering of birds alarmed at the fierce galloping of horses thundering past. The action of riders and beasts presaged momentous tidings. Well might those messengers have said :—

> "We have ridden the pale Moon out of the sky,
> Our hoof-beats drum up the dawn!"

The dawn, indeed—of the greatest era the world has ever seen!

Behind the messengers, in shrouded Windsor, William the Fourth lay dead. With the dead they had no concern. Using every sinew, straining every nerve, on they hurried to greet the living, on to Kensington Palace, so that no possible moment of time might be lost in telling to a sweet and gentle Princess that during the silent watches of that night the mantle of Majesty had fallen upon her maiden shoulders.

Kensington Palace is reached at last. The loud summons remains long unanswered—the household is wrapped in slumber. At length attendants are aroused. To them the message is confided: "Tell the Princess Victoria that the Archbishop of Canterbury and the Lord Chamberlain desire an immediate audience on urgent affairs of State." An attendant returns to say that the Princess is in such sweet sleep she could not venture to disturb her. The messengers are not to be denied. "We have come on business of State to THE QUEEN, and even her sleep must give way to that."

A few minutes pass on leaden wings. Then the door opens to admit a slender figure, clad in a loose white nightgown and shawl, her hair falling upon her shoulders, her feet in slippers. Tears fill her tender eyes; yet in nothing does she lack the perfect dignity of a woman and a Queen.

As the augury of a glorious sunrise touches all London with its splendid promise, the Victorian Era begins. An Empire awakes to say—God Save the Queen!

* * * * *

And now the Queen is dead! The stupendous tidings came to us on the evening of the 22nd ult., with resistless, awe-inspiring force. It seemed hardly credible; we could scarcely realise it. It is still difficult to reconcile our minds to the fact that the greatest reign in history is closed, that the Victorian Era is at an end, that "the Great Good White Queen" is for ever at rest. As the expected but feared news came to the people, an unconquerable feeling came with it that we had sustained a great and irreparable loss, that a close link had been broken. There came a sense that with the passing away of this splendid life a sharp incisive line of demarcation had been drawn across our very existence. The Queen had become to us such a part and parcel of our daily existence that it somehow hardly seemed possible to lose her. Generations of great people have come and gone, momentous changes have taken place, but the Queen seemed ever with us, an integral part of our system and our humanity, as it were. No wonder that her removal from our midst seems to have created a desolating void, a sense of unmitigated loss, deep and unfathomable.

The influence that our deeply mourned and dearly beloved Sovereign has exercised for the good of her people, the expansion of the Empire, and the advancement of civilisation can scarcely be measured. Hardly to-day can we gauge what she has individually been the means of accomplishing for her country and her subjects. It would doubtless fill a large volume to recount in detail the many

sagacious, benevolent, statesmanlike and devoted acts which have so graced Her Majesty's unrivalled life and so adorned her glorious reign above all others.

When Queen Victoria came to the Throne the Monarchy was greatly in disfavour with the people. The country was practically going through the ordeal of industrial revolution and a momentous political upheaval. Social conditions were generally bad; the low standard of comfort among the masses, the narrow limits of education, the various disabilities under which the working classes toiled and sweated, all tended to create a feeling which was dangerous to the State and the Throne, and republican doctrines were very near the thoughts and lips of a great many. Things looked the reverse of promising for the young Queen at the immediate outset of her regal career. She had apparently stupendous obstacles to face. The burden of the task of taking up the destinies of a great country, embroiled with difficulties at home and abroad, might well have been considered overwhelming by the frail girl of eighteen who was called upon to undertake the momentous duties. But with that calm resolution, exemplary fortitude, sincere faith, and unerring judgment which have so distinguished her long, blameless life, the Queen surprised her Ministers, the country, and the whole world by her grasp of the situation, and won an universal recognition of her sagacity, foresight, tact, and goodness which brought to her a power and might more potent than had ever been conceived possible.

By the Queen's example of true womanliness, and by all those qualities which have endeared her to us for all time, the Monarchy which was so discredited at the commencement of her reign was raised, glorified, exalted; the republican tendencies of the age which were manifesting themselves at the time of the demise of William the Fourth were transformed into a loyal adherence to the monarchical principle of government more solid and enduring than ever before.

Of the virtues of the great lady who has passed hence, one could write many pages, but space forbids, nor is it necessary; not only her people, but the world knew her and all her goodness of heart and mind. Her influence on our time will live as long as history is history. As a peacemaker, if for nothing else, she would go down to posterity as a benefactor of her country and mankind. A deadly and bitter war with America was probably averted by Her Majesty in 1861. History records other occasions; but how many unrecorded facts are there to make up the sum of the Queen's sagacious and successful efforts in the cause of humanity!

Like "the widening rings of a magnetic current," her beneficent influence and example have encircled the destinies of our country. Under her long and glorious reign has our magnificent Empire been built up and consolidated into the homogeny it represents to-day. That the Queen had a leading hand in promoting and fostering our far-reaching Imperial expansion is unmistakable; she virtually converted her statesmen into the belief of a Greater Britain. The last great convert to the Queen's ceaseless activity and consistent conduct in the cause of Colonial expansion and Empire was Lord Beaconsfield, who at one time spoke in the most disparaging terms of "those wretched Colonies," but who afterwards created the Queen, Empress of India, and was the most ardent Imperialist and expansionist of our times.

Undoubtedly our late Sovereign Lady was one of the greatest living factors in the promotion and development of the sentiment of the people, a sentiment which has had far-reaching results for the Empire. As with Foreign and Colonial affairs, so with momentous questions of home policy, she ever exercised a wise and beneficent influence. Most intensely interested has she been in many great measures for the amelioration of wrongs and for the removal of anomalous restrictions on the liberties of the people. Broad-minded and far-seeing was her statesmanship. It is one of the marvels of her wondrous reign that she practically encouraged and assisted the cause of democracy. The enfranchisement of the people, which her Royal predecessors feared, the Queen advocated and looked upon with equanimity. She trusted the democracy; her faith brought its own reward—the democracy understood, trusted, and revered her. Apart altogether from any of the other great

Acts which have so distinguished the rule of Her Majesty and which have so linked her name with the stupendous Imperial and industrial progress of the nineteenth century, if the measures concerning education had been the only great Acts passed it would signalise her reign as more than illustrious. To the Queen's initiative we must ascribe the elementary teaching of the poor and all the great results which have followed. That was a proud step forward in the progress of a great nation and a consummation worthy of a great Queen.

The Queen and the country seem to have been so inseparably a part of each other that one, in speaking of Her Gracious Majesty, must necessarily speak of the material and economic advancement of the great nation over which she so gently but firmly ruled, but the magnitude of even cursorily noticing the industrial and trade developments of the Victorian Era causes one to stand appalled. It would take thousands of eloquent pages to form the commercial story of Great Britain during the memorable epoch presided over by our good Queen.

The dominant note of Her Gracious Majesty's glorious reign has been progress, and progress on a splendid and unprecedented scale, and her noble example and influence have permeated through it all. The Victorian Era has been marked by such a succession of remarkable inventions and discoveries, and by the accomplishment of such magnificent and awe-inspiring feats, that the whole world of trade and commerce has been revolutionised not once, nor twice, but many times over.

In the panorama of progress that makes supremely illustrious the reign of Victoria, the engineers have played no second part. Their work during this period has had far-reaching effects upon the material interests of Great Britain and the British Empire, and the Queen's great and practical interest in the monumental achievements of her distinguished subjects was manifest at all times.

The Queen's dominions when she acquired them were widely scattered, a collection of isolated countries, out of touch with each other, lacking all but the slowest inter-communication, and not much of that. How great our Empire is to-day, and how great a part of that Empire Our Sovereign Lady was, the contents of the daily Press containing the records of grief-stricken communities in our vast possessions and dependencies but too eloquently testify. The developments of the Victorian Era have knit all together in one compact animated whole; and with one accord, spontaneous, heartfelt, and with a depth of sincerity which is unmistakable, our Great Empire mourns her. The death of William IV. was more than a year in reaching the confines of Greater Britain: in 1837 news spread like a slow ever-circling ripple upon the waters of Time. In 1901 the fact that our beloved Queen had passed away was known in her farthermost dominions almost as soon as in Osborne and London, and within a few hours a fourth of the civilised world was in mourning. But apart from our Colonies and dependencies, apart from all who have bowed the knee in allegiance to Her Gracious Majesty in the lands and countries where the Union Jack holds sway, there is a deep and profound sorrow felt and expressed by the men and women of all nations at the death of the Queen. And in the face of the calamity which has befallen Britain, the voice of calumny and detraction of our country and its works—which has unhappily been but too obtrusive during the closing years of the good Queen's reign—is silent! The fame of the Queen is Britain's, but her influence is the world's.

The name of the Queen stood for peace, for justice, for progress, for humanity, wise legislation, the spirit of a democratic age. She was most truly the representative of the human impulse in politics and society, the embodiment of everything noble and great in a Sovereign, upright, conscientious, patient, self-denying, of blameless integrity, of single-minded devotedness to duty and the concerns of her subjects, who in return gave to her an unswerving loyalty, measured only by the duration of their lives. Into the foundations of the British Empire has she built the most splendid and most enduring stone. Her acts, animated with the highest aims, have laurelled the long and glorious years of her reign with splendid crowns.

Victoria, the best beloved, the greatest of England's Queens, the wisest and best of British Sovereigns, needs no eloquent epitaph, no monument carved by human hands, to signalise her worth and work. Though the gentle spirit of the great lady—whose womanly sympathy, heroic fortitude, simple and beautiful life as Queen, wife, and mother, endeared her to all hearts—has departed to that bourne from whence no traveller returns, her memory will imperishably endure, and her splendid example will stand as a beacon light to successive generations of mankind for all time.

Truly did the Queen carry out the admirable prophecy with which her reign began—Lord Morpeth's speech to his constituents in the West Riding of Yorkshire a few months after the Queen came to the Throne: "Every Englishman must fondly look back to the wisdom of Elizabeth and the victories of Anne. But in shaping the desired career of their fair young successor, Victoria, we do not wish that her name should rise above the wrecks of the Armada; we do not seek to emblazon her throne with the trophies of such fields as Blenheim, or the yet more resplendent Waterloo. Let her have glories, but let hers be the glories of peace, of industry, of commerce, and of genius; of justice made more accessible, of education made more universal, of virtue more honoured, of religion more beloved, of holding forth the earliest Gospel light to the unawakened nations—the glories that arise from gratitude for benefits conferred, and the blessings of a loyal and chivalrous, because contented, people."

* * * * *

The perfect promise of that fair June morning—more than sixty years ago—remains abundantly fulfilled. Three generations upon this earth have come to know and appreciate the blessings that follow the reign of a good woman. How complete has been her reward. For there is no land under the sun—there is no nation, race or creed—that is not reverently and sincerely mourning her loss to-day.

"The Vision pales and dies
Which gladdened long our eyes,
Great Majesty in Womanhood enshrining;
She passes to her rest,
Victoria the Blest,
Her crown with a diviner lustre shining;
And, while her stricken people weep,
She lays her sceptre down and falls asleep.

* * * * *

"Not as we bring the bloom
To deck her kingly tomb
Shall we survey the splendour of her glory;
But in the after years,
When pride hath dried our tears,
Our children shall be told her wondrous story.
Now let her rest, in Jesus sleeping—
God guard her ever in His holy keeping!" ROBERT DENNIS.

* * * * *

And so the glorious reign is ended; the golden age of Victoria is closed. The history of the nineteenth century is practically the history of our great Sovereign, who will go down to posterity as the great, good Queen, and the unerring judgment of time will give her the fullest measure for the magnificent legacy she has bequeathed to the unborn generations. The incomparable hold that the Queen has had upon the affections of her people will never be dispelled as long as life lasts. With her passing away the great era is finished, but let us fervently hope that the new epoch, beginning with the twentieth century and the reign of EDWARD VII., the dearly-loved son of Her Majesty, will be, as it were, a continuance and fruition of the imperishable era so indelibly associated with the great Queen's reign.

T. F.

God Save the King.

"We are, in the vastness of our possessions, losing our grip on national sentiment. It is our duty to maintain intact, and to defend by sea and land, all that our empire builders have left us. The day that sees the defence of the British Empire sapped, sees the disintegration of the Nation's trade and the hands of civilization's timepiece put back 200 years."—RT. HON. LORD CHARLES BERESFORD, C.B.

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Great Copper and Lead Mines now being developed in Tuscany.

WE recently received information that a group of Englishmen were developing some very extensive copper and lead mines in Tuscany, and in view of the enormously increasing demand for copper, due to the number of traction and other electrical schemes now actually being carried out, or which will be carried out within the next few years, while the supply is at present controlled by trusts, we decided to send out a special commissioner to investigate the truth of the reports.

He has visited the estate, descended the principal shafts and tunnels, examined the principal outcrops, and inspected for himself the great bodies of ore, in view of which he has brought back interesting specimens, together with photographs, some of which are reproduced in his account of the mine, which will be found on another page.

The accounts which reached us in the first place, although from a source which we considered exceptionally reliable, were so remarkable, both with respect to the magnitude of the lodes and the concurrence of favourable conditions for the working of the mines, that we decided not to lay them before our readers until they had been verified by our special commissioner.

The assay results and the details of measurement of the lodes have been taken from the engineer's figures, but our special commissioner has thoroughly satisfied himself by examination both on the surface and underground, and by inspection both of the ore *in situ* and of the various heaps which have been raised to the surface, that these figures are certainly not exaggerated.

Where Men Must Work . . .

EDUCATION in Chicago is the best in the world for fitting a youth for the battle of life. As specialisation is practically the rule in American workshops, apprenticeship is not popular either with employers or men, for the employer wants a man to do one kind of work, and the man wants to begin earning money right away, and to earn more in proportion to his growing capacity. The youth therefore learns how to handle machinery at a training school, and when he starts real work he is able at once to earn about 15s. a week. Rapid increases follow if he proves to be dexterous, as piece-work is the rule, and very often he will keep to the same class of machine for the remainder of his working days. In Chicago, it may be said that these are strictly numbered, as will be gathered from the statement that the average age of the workman in one of the largest engineering shops is not more than 32. The fact is that very few men of 45 retain their original speed, accuracy, or sight, and the manufacturer simply will not keep on a man at an expensive machine unless it is being worked at its full ascertained capacity. Directly a man ceases to

pay, out he goes. He may be willing to work and to do his very best, but if he falls short of the standard by a mere percentage, the employer will not have him at any price. The masters there want to do all the trade they can while it can be obtained; the men want to earn all the money they can, and as a rule an American can earn as much money in 25 years as one of our Unionist men is paid in 50 years. There is common-sense in all this, and when our masters and men begin to act in the same way we shall hear a good deal less about foreign competition.

From Birmingham to the Sea . . .

A NUMBER of public authorities, recognising how extensive is the traffic between the Birmingham district and the Bristol Channel, are desirous of forming a committee, representing the towns of the Midland producing area and the Bristol Channel shipping interests, for the purpose of considering how water communications may be improved. Manufacturers are at present heavily handicapped by high railway rates, as well as by the fact that railways are not adapted for carrying some classes of goods and raw materials. The rates are three or four times as much as are paid by commercial competitors abroad, and it is intensely irritating to reflect that whilst railway charges are still rising in this country, they are steadily falling in other countries. It appears to be hopeless to expect relief through reduction of railway rates, because the actual cost of transport is itself increasing. These things show the desirability of providing other means of transport, and we quite agree with Sir Alfred Hickman that the provision of waterways between the interior and the sea is essentially a national concern. That this view is not shared by the new President of the Board of Trade, merely demonstrates anew the absurdity of committing important interests to the charge of men who are totally unqualified by training and experience to deal with them. A very similar project has lately been considered in the United States by a Government commission, and we believe the new waterway will be constructed and maintained by the State. The Americans are too practical to permit an undertaking of such national importance to be neglected. That is one reason why they succeed where we fail.

Pneumatic Signal Apparatus . . .

WE are always glad to hear of improvements, from whatever source they may originate. The innovation to which attention is now directed is a system of pneumatic signalling, which has been used for years on American railroads with the greatest success. It is shortly to be made the subject of a practical test at the Basingstoke Junction of the London and South-Western Railway Company. Everyone who knows anything at all about the working of a railway is familiar with the archaic and complicated nature of the apparatus now used in an English signal-cabin, to manipulate which the signalman is expected to combine the muscular attributes of a coal porter, the mathematical accuracy of a chronometer, and the unconquerable vitality of an insurance canvasser. It is at the suggestion of Mr. Sam. Fay, traffic superintendent of the South-Western line, that the pneumatic apparatus will be installed at Basingstoke. If satisfactory there, it will be introduced at Waterloo Station, where, as our readers know, signalling operations are conducted on a more extensive scale than at any other station in the world. Besides lightening the duties of the signalman, the new apparatus will cost less in maintenance, as it cannot get out of order or be damaged like the mechanical appliances now used; it is not affected by weather, and requires no adjustment. Board of Trade regulations have, of course, to be complied with, but we cannot think these will constitute any insuperable obstacle; and it is sincerely to be hoped that the results obtained by the London and South-Western Railway Company may be such as to impel all other railways in the country to follow so excellent a lead.

An Anomalous Condition . . .

THERE appears to be a safe investment for capitalists in the formation of a company for the purpose of constructing additional cable lines between Great Britain and Germany. It will come as a surprise to many of our readers to learn that merchants in Bremen are obliged to obtain their information regarding the fluctuations of the Liverpool exchange by way of New York, because they receive it in this way far quicker than they would receive it if it were cabled direct. This is due to the insufficiency of the Anglo-German cables, which causes an accumulation of messages during the period of great business activity. The Berlin merchants obtain in the same roundabout way their cable news from London, *i.e.* it is first cabled from the English metropolis to New York, and thence re-transmitted to the German capital. As in this way an additional amount of nearly two shillings per word has to be paid, and is willingly paid on account of the earlier arrival of the telegrams, it is obvious that the construction of new cables direct to Germany would yield to the owners heavy profits, and it is strange that there have been no financiers so far to avail themselves of this opportunity.

Defective American Steel Plates . . .

JUST as some American machine tools have recently been discovered to be hardly up to their vaunted standard, so we now learn that a quantity of steel ship plates imported from the United States had to be rejected, and it seems as if our Transatlantic cousins are beginning to grow careless through their over-confidence in themselves. The importing of American ship plates has been going on for some time, and the consignees were apparently satisfied with the foreign article. Recently, however, a rather large consignment of plates sent to Messrs. Workman, Clarke & Co.'s shipyard at Belfast was, according to the *Trade Journals Review*, rejected on account of many of them being unable to bear Lloyd's tests. These plates were supplied by the Lukens Company, Coatesville, and the incident will probably somewhat shake the confidence of British consumers in foreign goods. It is stated on behalf of the manufacturers that the error was due to some technical inadvertence. The Company, it is said, being hard pressed for time, sent off the plates before Lloyd's official had arrived to make the test, but retained portions of the plates as test pieces. When the official arrived he at first refused to take it for granted that the pieces were actually taken from the plates sent off, and refused to make the test. Later, however, after some inquiry he consented, and it was then found that several of the test pieces failed to meet the requirements. This, of course, led to the condemnation of the whole lot. The Lukens Company promptly put in hand a repetition of the whole order; but, of course, the occurrence cannot but produce an unfavourable impression. And we may well ask ourselves whether our importers of American products fully realise the temptation to which the American manufacturer is exposed through knowing the fact that his successful competition with British makers depends upon engaging himself to deliver his goods within a space of time which his British rival considers too short for the turning out of creditable work?

The Hoisting of the German Flag . . .

THE United States Government appear to have decided to push forward everything which will create for their country a great mercantile marine. Congress will almost immediately resume consideration of the Shipping Subsidy Bill. As that Bill now stands, foreign-built ships engaged in a certain traffic and on the American Register may get a certain amount of subsidy, and ships owned by foreigners are also admitted within its provisions to receive benefits. But it is the intention to amend the Bill in many important particulars, so that it will become more exclusively drawn to benefit American shipping only. It will be proposed to cut out the clauses which provide advantages to foreign vessels, and make

the subsidy applicable to ships built in American yards, and owned by Americans. As the Bill is at present drawn, a subsidy is proposed for the fast passenger Atlantic steamers. It is proposed to reduce this subsidy, for it is argued that these steamers will be run to carry passengers and mails in any case. It will be proposed to increase the grant to the slower cargo boats. This will be another grievance added to the very long list now complained of by British shipowners. Already they complain of the hardships inflicted on them by the hard and fast Board of Trade rules. These rules, as administered in British ports, they say, are simply instruments directed against British shipping, to prevent their successful competition with foreign vessels. There is no advantage, indeed there is a serious disadvantage, in sailing under the English flag, for the rules under which ships must do so inflict on them conditions and expenses greater than those borne by the foreign vessels trading on the same line in competition with them. During the month one line has hauled down the English flag and hoisted the German, and there are rumours that another will soon follow suit. There is little question of any change in the personality of the shareholders or the owners of the ships when the transfer is made. The change is only made to make the conditions of sailing and the prospects of sucessful competition better. Recently it came out that when a ship belonging to a British owner was sold to a German, and sailed under the German rules, she cleared in profits £1,000 more a year. While, then, we hear of foreign Governments, and especially the Governments of Germany and the United States, offering every inducement to their own shipowners and shipbuilders in the shape of subsidies and easy conditions of sailing, we hear of nothing in England but stupid decisions against British shipowners in the Courts of Law and the fixing of onerous conditions of sailing by the Board of Trade. The hoisting of the German flag over the English mercantile marine is fast becoming a regular item of news.

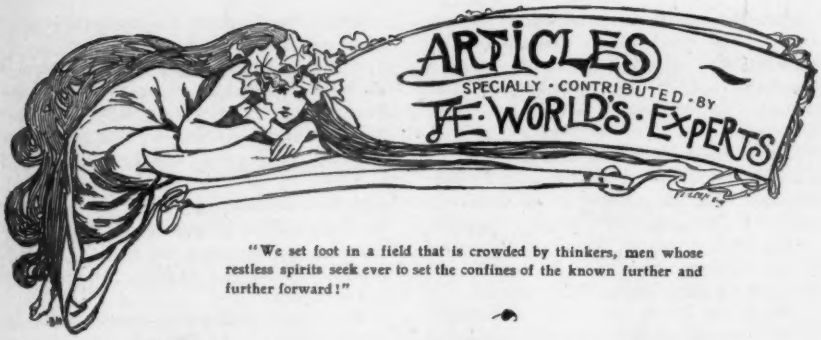
A Cotton-Trade Problem . . .

For some time past Lancashire cotton manufacturers and merchants have had to face increasing American competition in Chinese markets. As we all know, there was once a happy period when Manchester used to supply the United States with manufactured cotton in exchange for the raw material. But the Americans soon conceived the idea of establishing mills for the production of such goods as were required in their own land. Afterwards came the inevitable increase, and American competition began to be experienced in other markets. Cotton mills in the Southern States have multiplied wonderfully during comparatively recent years, until they have become remarkably keen and successful competitors with Lancashire, especially in China. For the year ending June 30, 1899, the total exports of manufactured cotton from the United States amounted to 412,004,055 yards, representing a monetary value of nearly £4,000,000. Of this quantity about 10 million yards were shipped to the United Kingdom, and nearly 50 million yards to various British possessions. But no less than 221 million yards were exported to China. During the year which terminated in June last a considerable diminution was exhibited in the amount absorbed by Chinese markets, owing in great measure to the general disruption of affairs in that empire. One significant result of the present state of business in Shanghai is that a number of mills in the Southern States have been compelled to revert to short time. This shows clearly that American manufacturers by no means rely upon home demands, as some optimistic people are apt to suppose. Undoubtedly, the cost of production in the Southern States is low in consequence of several natural advantages, but it is admitted in Manchester by those competent to judge that the Americans are more successful than our own manufacturers in the manipulation of certain goods during the processes of weaving, bleaching, dyeing, and printing.

SUP

Supplement to
FEILDEN'S MAGAZINE,
February, 1901.

800 I.H.P. COMPOUND VERTICAL ELECTRIC TRACTION ENGINE, BUILT BY MESSRS. D. STEWART & CO., LTD., GLASGOW, FOR THE GLASGOW CORPORATION.



"We set foot in a field that is crowded by thinkers, men whose restless spirits seek ever to set the confines of the known further and further forward!"

Thermal Efficiency of Steam Engines.

By W. D. WANSBROUGH.

MR. WANSBROUGH has been connected with one of our largest firms of steam engine makers for the last 25 years; for the last twelve as Works Manager, in which capacity he has superintended the construction of—and tested—more than ten thousand engines.

He has written "The Portable Engine, its constrction and management," "The Proportions and Movement of Slide Valves," "The ABC of the Differential Calculus," and has contributed to various British and Foreign periodicals a large number of articles signed and unsigned, chiefly on Steam Engines and Steam Boilers, in theory and in practice, with many others upon various social and economical topics.

THE usual method of fixing or ascertaining the economic value of a steam-engine's performance is in terms of the weight of feed-water used in developing one indicated horse-power per unit of time. Recollecting that the steam-engine is really a heat engine, and that the steam is only one link in the chain through which the heat stored in the fuel is enabled to do actual mechanical work on the piston, we see at once that the expression of value which ought to be used is not one of quantity of water but of quantity of heat.

So long as the steam supplied to the engine is saturated steam, that is to say, steam of the temperature of the boiling water producing it, the distinction is not one of great importance; but unless we are prepared to approve the principle of using one standard of thermal efficiency for an engine working with saturated steam, and others for the cases of engines using superheated steam, gas, oil, or air, it is clearly desirable that some method applicable to all heat engines under all circumstances should be devised.

Such a method is the one embodied in a Report prepared at the request of the Council of the Institution of Civil Engineers, by a Committee appointed to consider the subject of the definition of a standard of thermal efficiency for steam-engines, under the presidency of Dr. A. B. W. Kennedy.*

The character and composition of the

* With an Introductory Note by Capt. H. Riall Sankey, Hon. Secretary to the Committee.

Committee afford a convincing proof not only of the need which existed for the authoritative determination of such a standard, but of the completeness and accuracy of the work which has been accomplished.

The Report itself is to a large extent of a highly technical character, and, in fact, assumes that the reader is fairly conversant with the science of Thermo-dynamics.

The real simplicity which distinguishes the new rating, the ease of its application to cases in practice, and the universality of its grasp, are by no means so evident to the general reader as are the exceeding thoroughness and elaboration of the investigations which have enabled the Committee to confidently put forth so simple a solution of the existing and acknowledged difficulty.

The committee recommend that the thermal economy of a steam engine be stated in terms of the thermal units required per minute per indicated horse-power, and that, where possible, the thermal units required per brake horse-power be also stated. Also, that for scientific purposes there be stated the thermal units required per indicated horse-power per minute by the "standard engine of comparison," which can readily be obtained from a diagram (see Figs. 1 and 2), and from which the efficiency ratio can be deduced.

The proposed method of statement is applicable to engines using superheated steam as well as to those using saturated steam; and the objection to the use of pounds of feed-water, which contain more or less thermal units, according to conditions, is obviated; while there is no more practical difficulty in obtaining the thermal units per indicated horse-power per hour than there is in arriving at the pounds of feed water, as will be immediately seen by a consideration of the following example.

Suppose the following observations are made with an engine using saturated steam (Case 1).

Indicated h.p.	520
Weight of steam entering engine per min.	108·3 lbs.
Stop-valve pressure per sq. in. (absolute)	170 ,,
Exhaust pressure per sq. in. (absolute)	2 ,,

From these data all the particulars required can be obtained thus:—

The heat supplied per pound of feed is in thermal units 1,194—94 = 1,100 units. Multiplying by the pounds of feed per minute, and dividing by the indicated horse-power, we have $\frac{108{\cdot}3 \times 1{,}100}{520} = 229$, and this number 229 is a true measure of the thermal economy of the engine, namely, the number of British thermal units supplied per minute per indicated horse-power.

The statement above simply expresses the following:—The heat supplied to the engine is equal to the total heat of the steam entering the engine, less the water heat of the same weight of water at the temperature of the engine exhaust, both quantities being reckoned from 32 degs. Fahr. After a series of experiments (Appendices II. and IV.) the Committee recommend that the pressures and temperatures, or both, be taken in the following manner:—

Upper limit; the temperature and pressure close to (but on the boiler side of) the engine stop-valve.* In the case of saturated steam, the temperature corresponding to the pressure can be taken.

Lower limit; the temperature in the exhaust pipe close to, but outside, the engine. The temperature corresponding to the pressure of the exhaust steam can be taken.

It may be convenient here to explain how the figure of 1,100 thermal units is arrived at from the data given in the example.

The thermal or heat units referred to in this article are British thermal units. Degrees of temperature are uniformly degrees Fahrenheit, and steam pressures are always absolute—*i.e.* reckoned from a vacuum. The B.T.U. is the standard measure of heat in this country, and for present purposes may be defined as the quantity of heat absorbed by 1 lb. of water in raising its temperature 1 deg. Fahr.

We have only to refer to any table of saturated steam to find the temperature

* Except for the purpose of calculating the standard of comparisons in cases where the stop-valve is purposely used for reducing the pressure. In such cases the temperature of the steam at the reduced pressure shall be substituted.

and the total heat for steam of any given pressure. Though perhaps hardly necessary, it may be convenient to recall the reasoning by which the established figure of 1,194 units is assigned as the total heat of steam at 170 lbs. absolute pressure. The appropriation of the heat expended in the production of 1 lb. of steam at atmospheric pressure from water supplied at 32 degs. Fahr. may be exhibited thus :

	Units of Heat.	
SENSIBLE HEAT EXPENDED—		
By raising the temperature of the water from 32° to 212° Fahr., while slightly expanding the volume -		180·9
LATENT HEAT EXPENDED—		
(*a*) In the formation of steam	892·9	
(*b*) In resisting the incumbent atmospheric pressure of 14·7 lbs. per sq. in, or 2,116·4 lbs. per sq. ft.	72·3	
		965·2
Total or constituent heat -		1,146·1

Further, for each increment of 1 deg. Fahr. of temperature above 212 degs. the total heat of saturated steam increases at the rate of ·305 of a unit. Hence the expression for the total heat of saturated steam of any temperature, t, above 212 degs. Fahr. is $1{,}146 + {\cdot}305\ (t - 212)$, which, in the present case, is $1{,}146 + {\cdot}305\ (368 \text{ degs.} - 212) =$ say, 1,194.

The heat expended in raising 1 lb. of water from 32 degs. to 126 degs., which we find by the table to be the temperature of steam at 2 lbs. absolute pressure, is, of course, 94 units. Deducting this from the 1,194 units contained in the steam at stop-valve pressure, we arrive at the figure of 1,100 as the number of heat units utilised per pound of feed.

To take another example (Case 2) :—

Stop-valve pressure - - -	158 lbs.
,, temperature - -	362°
Exhaust ,, - - -	213°
Indicated horse-power - - -	500
Brake ,, - - - -	450
Weight of steam entering engine per minute - - - - -	171 lbs.

Hence $1{,}146 + {\cdot}305\ (362 \text{ degs.} - 212 \text{ degs.}) = 1{,}192$ units in entering steam, and 213 degs. − 132 degs. = 181 units in water-heat of exhaust steam. $1{,}192 - 181 = 1{,}011$ units supplied per pound of feed — $\therefore \frac{171 \times 1{,}011}{500} = 345$ units per indicated h.p. per minute, and $\frac{171 \times 1{,}011}{450} = 384$ units per brake h.p. per minute.

Case 3 is an engine using superheated steam :—

Stop-valve pressure - - -	185 lbs.
,, temperature - -	650°
Exhaust ,, - -	100°
Indicated horse-power - -	1,300
Brake ,, - - -	1,155
Weight of steam entering engine per minute - - - -	222 lbs.

The tabulated temperature for saturated steam of 185 lbs. absolute pressure is 375 degs., hence $1{,}146 + {\cdot}305$ (375 degs. − 212 degs.) = 1,196 units. But the temperature given above, 650 degs., shows that there is 275 degs. of superheat to be taken into account.

The number of units of heat contained in 1 lb. of super-heated steam is ·48 for each degree Fahr. of super-heat.

Hence we have in this case $1{,}196 \times {\cdot}48 + 275$ degs. = 1,328 units in entering steam; and deducting from this, for the water-heat of the exhaust steam, 100 degs. − 32 degs. = 68 units, we get 1,260 as the number of units supplied per lb. of feed.

$\therefore \frac{222 \times 1{,}260}{1{,}300} = 215$ units per i.h.p. per min. and

$\frac{222 \times 1{,}260}{1{,}155} = 242$ units per b.h.p. per min.

In the three examples already given we have respectively 229, 345, and 215 units of heat supplied per indicated horse-power per minute. We can estimate the comparative economy of these three engines, but there is an evident want of some standard by which their actual value can be measured; and this brings us to another step in the investigation, the "standard steam-engine of comparison," as the Committee have chosen to name it.

"Actual steam-engines fall far short of the perfect steam-engine, owing principally to incomplete expansion, to the use of conducting materials for cylinders, and to the clearances that have to be observed for mechanical and other reasons."

The ideal steam-engine is conceived as working upon the Rankine cycle, and is

assumed to be the standard for both saturated and super-heated steam-engines. The number of heat units per minute per i.h.p. required by this ideal engine depends upon the temperature of the steam at admission and at exhaust, and also upon whether the steam is saturated or super-heated.

In the Rankine cycle the following assumptions are made:—

No clearance in the cylinder; no losses due to initial condensation, leakage, radiation, or conduction; and no defects in any of the component parts of the steam plant. The cycle itself is thus defined: The feed-water required is taken into the boiler at the exhaust temperature, and its temperature is gradually raised until that corresponding to saturated steam is reached.

Steam is then formed at constant pressure until dry saturated steam is produced; after which, if the steam is to be superheated, heat is added at constant pressure and at increasing temperature until the required temperature of superheat is reached.

The steam is introduced into the cylinder at constant pressure, displacing the piston and performing external work equal to the absolute pressure multiplied by the volume swept through by the piston up to the point of cut-off.

Beyond that point expansion takes place adiabatically, doing work until the pressure in the cylinder is equal to the back-pressure against which the engine is working. The steam is then completely exhausted from the cylinder at constant pressure corresponding with the lower limit of temperature, work being done on the steam by the engine during exhaust equal to the absolute back-pressure multiplied by the total volume swept through by the piston. The steam is then removed from the cylinder, and the cycle is complete.

To calculate the heat supply in any particular case the only data required are the higher and lower limits of temperature, and for superheated steam the admission pressure as well.

The formulas for the Rankine cycle being somewhat complex, the Committee have prepared the curves shown in the

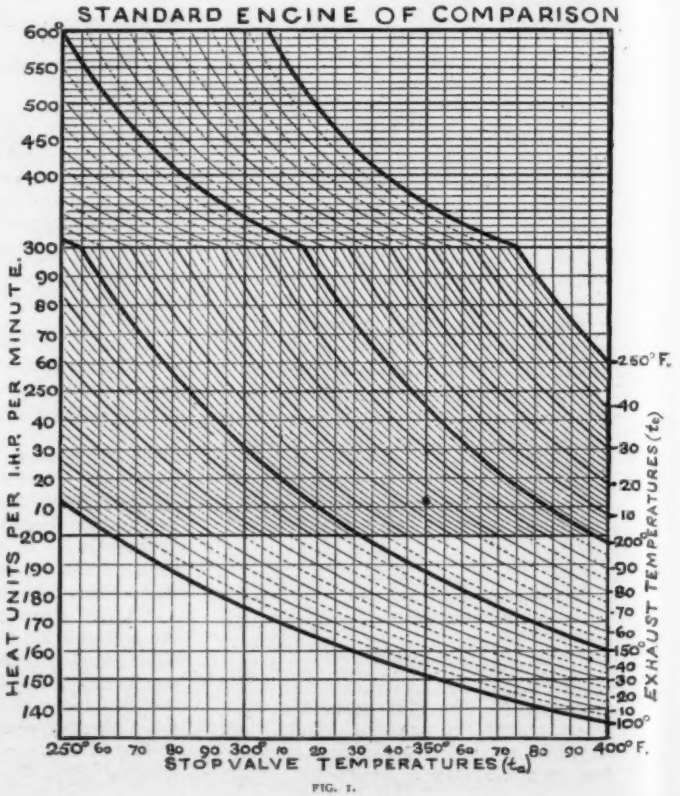


FIG. 1.

diagram, Fig. 1, from which the number of heat units expended by the standard steam engine of comparison per indicated horse-power per minute can be read off—without calculation for the case of saturated steam, and in the case of superheated steam by applying a correction to the result obtained for saturated steam.

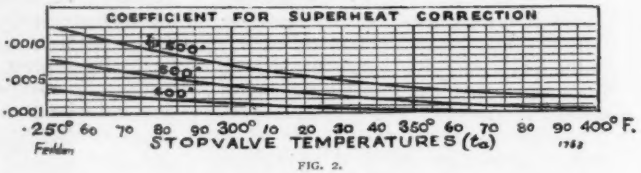


FIG. 2.

In Fig. 1 the curves are indexed on the right-hand side of the diagram from 100 degs. to 250 degs. for values of t_e, the exhaust temperature. It will be noticed that the upper and lower portions of the diagrams are to different scales; this is in order that the lower and more important part may be read more easily, and accounts for the cusps in the curves. The temperatures are, of course, expressed in degrees Fahrenheit.

To use the diagram:—

Find the curve corresponding to the exhaust temperature, and follow it upwards till it is intersected by the ordinate representing t_a, the stop-valve pressure, which is indexed along the base line from 250 degs. to 400 degs. The vertical height of this intersection, as measured by the scale indexed on the left-hand side of the diagram, gives at once the heat units expended per indicated horse-power per minute by the "standard steam-engine of comparison."

For instance:—Let 212 degs. be the exhaust temperature t_e, and 360 degs. the stop-valve temperature t_a, the intersection of curve 212 and ordinate 360 will be found to occur on the horizontal line marked 250 on the left-hand scale. Hence the standard engine, working between the temperatures given, would expend 250 units per indicated horse-power per minute. The engine of Case 2, with t_a 362 degs. and t_e 213 degs. would also expend 250 units.

The small diagram, Fig. 2, contains a set of curves marked "Co-efficient for Superheat Correction." Against the temperature of saturation corresponding to the stop-valve pressure, and on the curve corresponding to the temperature of the super-heated steam, t_{as}, is found a co-efficient. This co-efficient, multiplied by the exhaust temperature, and by the result already found, gives the correction in the form of a deduction from this result.

For example, take the case of an engine where:—

Stop-valve pressure, p_a	- -	135 lbs.
,, temperature, t_{as}	- -	500°
Exhaust ,, t_e	- -	212°

The temperature of the saturated steam at a pressure of 135 lbs. absolute is 350 degs., and, making use of Diagram I., we find that the standard engine, working with saturated steam between the temperature limits of 350 degs. and 212 degs., would expend 265 units per indicated horse-power per minute.

We have now to correct this result for the superheat. In Diagram II. are three curves for t_{as} of 400, 500, and 600 degrees respectively. Taking the 500 degs. curve, we find that it intersects the ordinate of 350 degs. at a point which, measured by the vertical scale on the left-hand side of the diagram, gives the co-efficient ·00015. This gives the correction thus: ·00015 × 212 degs. × 265 units = 8·5 units, and 265 − 8·5 = 256·5, the number of units expended.

Now, to apply this to Case 3, where the temperature of the incoming steam, t_{as}, is 650 degs., and the temperature corresponding to the pressure or t_a is 375 degs., with an exhaust temperature, t_e, of 100 degs.

From Diagram I. we deduce that the expenditure of heat between 375 degs. and 100 degs. would be 142 units. For the superheat correction we have to estimate the position of a 650-degs.' curve. This would, if drawn, very nearly cut the ordinate of 375 degs. at a height of ·0004 by the left-hand vertical scale — thus, ·004 × 100 degs. × 142 units = 5·68 units (or, say, 6) and 142 − 6 = 136, the corrected number of units, which would be expended by the standard engine of comparison under the given conditions.

Now we are in a position to see what ratio the performance in heat units per indicated horse-power per minute, in each of the cases we have been considering, bears to that of the ideal steam-engine, which forms the standard of comparison.

In Case 2 we found that in the actual engine 345 units per indicated horse-power per minute were expended, while in the ideal engine only 250 are required. Its "efficiency ratio" is therefore recorded as $\frac{250}{345} = \cdot 725$.

In Case 3 the figures were 215 actual and 136 ideal, the efficiency ratio being $\frac{136}{215} = \cdot 633$. The actual heat units lost in each case were respectively $345 - 250 = 95$, and $215 - 136 = 79$—a valuable and suggestive piece of information.

But there is one more ratio which may be deduced from the data at disposal, and that is the "thermal efficiency"—in other words, the ratio $\frac{\text{Heat utilised as work on the pistons.}}{\text{Heat supplied to the engine.}}$

The relation between the measure of one indicated, or piston, horse-power, and the measure of the mechanical equivalent of one heat unit is $\frac{33{,}000}{778} = 42 \cdot 4$; and if we divide the energy of one horse-power expressed thus in heat units, viz. 42·4 by the heat units required per indicated horse-power per minute, we obtain the thermal efficiency.

Thus the thermal efficiency of the engine of Case 2 is $\frac{42 \cdot 4}{345} = \cdot 123$; and of the engine of Case 3, $\frac{42 \cdot 4}{315} = \cdot 197$.

The fuel consumption can be easily calculated from the data already given. Thus, in Case 1, we have 229 units of heat used per indicated horse-power per minute. Assuming the coal to have a calorific value of 12,000 units per lb., and that 70 per cent. of the heat in the coal, or 8,400 units, is actually transmitted to the steam, the coal required would thus be $\frac{229 \times 60}{8400} = 1 \cdot 64$ lbs., say, per indicated horse-power per minute.

This is, of course, on the supposition that the feed enters the boiler at exhaust temperature, since the heat supplied to the engine is calculated from this temperature. If, however, the feed is supplied at a higher or a lower temperature, a correction must be made, which may take this form: $\frac{\text{Exhaust temperature—Feed temperature}}{\text{Total heat supplied to engine.}} \times$ lbs. of coal. Hence for Case 1 we have, assuming that the feed is raised, by an economiser or otherwise, to 200 degs., $\frac{126 - 200}{1{,}100} \times 1 \cdot 64 =$ say $- \cdot 11$. The correction is thus $- \cdot 11$, and $1 \cdot 64 - \cdot 11 = 1 \cdot 53$, the coal consumption in pounds per indicated horse-power per hour.

In Case 2, with the same coal, we should have $\frac{345 \times 60}{8{,}400} = 2 \cdot 46$; and if we assume that the feed enters the boiler at 62 degs., owing to there being no economiser or feed-heater, the correction would be $\frac{213 - 62}{1{,}011} \times 2 \cdot 46 = \cdot 36$; and $2 \cdot 46 + \cdot 36 =$ a coal consumption of 2·82 lbs. per indicated horse-power per hour.

In Case 3, supposing that 9,000 units per pound of coal burnt are transmitted to the steam, the coal consumption is, if the feed is at exhaust temperature, $\frac{215 \times 60}{9{,}000} = 1 \cdot 43$ lbs. of coal per indicated horse-power per hour. If the feed is supplied at, say, 320 degs., the necessary correction becomes $\frac{100 - 320}{1{,}260} \times 1 \cdot 43 = - \cdot 25$, and $1 \cdot 43 - \cdot 25 = 1 \cdot 18$ lbs. per indicated horse-power per hour.

As an approximate general rule, instead of the actual total heat supplied to the engine being used as the denomination of the correctional fraction, the number 1,000 may be used, as the total heat does not usually vary to an important extent from this. In cases of superheated steam, however, an addition in the form of $\cdot 48 \times$ degrees of superheat* must be made, so that in Case 3, for instance, we should have $\frac{100 - 320}{1{,}000 + \cdot 48 \times 275} \times 1 \cdot 43 = - \cdot 27$, and $1 \cdot 43 - \cdot 27 = 1 \cdot 16$, which only differs by ·02 from the result given above.

* *I.e.*, the number of units contained in 1 lb. of superheated steam per degree Fahrenheit of superheat.

In cases where the engine is fitted with a steam-jacket the steam passing through the cylinder abstracts heat from the jacket steam, which is clearly chargeable to the heat account of the engine. The same thing applies where a reheater is used. But when the drains from jackets or reheaters are returned to the boiler, the heat so returned must be credited to the engine.

The heat returned by jackets and reheaters can be calculated if the weight of the steam passing through them, and the temperature at which the resulting water is returned to the boiler, are known. Thus, for the engine of Case 1, supposing the results already found to have been attained by the aid of a steam-jacket and a reheater, we should have to make the following additions to the heat units per minute expended, as there shown—viz. 119,130 (*i.e.* 108·3 × 1,100).

Thus total heat of, say, 12 lbs. of steam into jacket per minute = 12 × 1,194 = 14,328. From this deduct heat returned at, say, 330 degs. = 12 × 298 = 3,576, making 10,750 units, which, added to the previous figure, 119,130, brings up the net heat supply per minute to 129,880. The corrected number of heat units per minute per indicated horse-power then becomes $\frac{129,880}{520} = 250$, instead of 229.

Supposing a reheater to be fitted in addition, using 10 lbs. of boiler steam per minute, and draining into boiler at 330 degs., we should have—Total heat of, say, 10 lbs. of steam into reheater per minute = 11,940 ; less heat returned at 330 degs. = 2,980, or 8,960 units, which, added to the previous result, and divided by the indicated horse-power, gives a final result of $\frac{138,840}{520} = 267$ units per indicated horse-power per minute.

In cases where the jackets or reheaters drain to waste there is, of course, no deduction to make on account of heat returned to the boiler, and the total heat of the jacket steam is necessarily debited to the engine.

Even this brief and partial survey of the Thermal Efficiency Committee's Report will be sufficient to show the simplicity and comprehensiveness of the system they recommend for adoption.

Perhaps, one day, we may even attend the funeral of the "nominal horse"!

W. Worsdell.

Midland Railway Enterprise.

New Line from New Mills to Heaton Mersey.

By C. E. ALLEN, A.I.Mech.E.

FROM a hasty glance at an up-to-date railway map of England the inexperienced have thought that there were railways enough, at least in the vicinity of the large manufacturing towns, being circumscribed as they are by a veritable network of lines. But the ever-increasing stress of competition or of traffic renders heavy and expensive new lengths of frequent necessity, although in spite of the recent completion of the Great Central Railway into London it is not so much on account of the former as of the latter reason that the Midland Railway Company have been under the necessity of expending such a large sum for the purpose of increasing their traffic facilities into Manchester. The already excellent services into that town, over by no means an easy road, are deservedly popular, so much so that it was found necessary to widen the Midland route. As, however, the present route between New Mills and Heaton Mersey lies over joint lines, it was decided to construct an entirely new line between those places, and an Act to authorise this was obtained by the Company in 1897.

MR. H. P. MILES, A.M.INST.C.E.,
Resident Engineer, Contract No. 1.

Not only will the new route give the Midland Railway Company a line of their own, but it will shorten the distance into Manchester by 1½ miles, and avoid several busy junctions, some very sharp curves and steep gradients, although, owing to the hilly district traversed, considerable expense has been incurred to keep the gradients flat enough and the curves sufficiently easy for fast running.

As will be seen from the accompanying sketch-map the new line commences at a point situated a few hundred yards to the south of New Mills station, leaving the original Midland line from Derby to the right. From this point to Hazel Grove, a distance of 5½ miles, constitutes the first contract, which was let to Messrs. Walter Scott & Co., of Newcastle-on-Tyne and London, in June, 1898, the work involved in the earlier portion of that length being distinctly heavy.

For the first 6 chains the line traverses an embankment requiring 1,300 cubic yards of material to build, and immediately enters a cutting extending for a distance of 9 chains, which is in rock, and from which was removed 40,000 cubic yards.

From 16 chains to 27 chains the line is carried on a viaduct, an imposing-looking structure of 245 yds. in length, and at an average height of 55 ft. from the ground to the rails. The viaduct is on a curve of 40½ chains radius, and consists of 13 arch spans of 45 ft. each, with a rise of 21 ft.

MAP SHOWING ROUTE TAKEN BY THE NEW LINE.

The fourth and fifth arches cross the river Goyt, and are on the skew, the angle being 65 deg. The piers are 29 ft. wide and 6 ft. 7½ ins. thick at the springing, and have a batter on the sides and ends of 1 in 40. The abutments, piers and spandril walls are built of snecked masonry; and the parapets, in which are placed manholes 3 ft. wide by 18 ins. deep, and about 100 ft. apart, are built of block in course masonry. The arches, which have a radius of 22 ft. 6⅝ ins., are built of brickwork faced for an average depth of 7 ins. with Staffordshire brindled bricks. The stone for the face work is Derbyshire grit stone, obtained from the quarries in the neighbourhood of Rowsley and Whatstandwell, while the stone used in the backing comes from the rock cutting close to the viaduct.

Fig. 2 shows a longitudinal section taken through four of the arches, while Fig. 4 is a transverse section the left half of which is taken through the centre of the arch and the right half through the centre of the pier. Fig. 3 shows details of parapets and spandril walls, while Fig. 1 gives a general view of the viaduct in course of construction, taken from the S.E., that is from the left-hand side of the railway in a direction travelling towards Manchester.

Leaving the viaduct, the line is again on an embankment 10 chains in length, and of an average depth of 50 ft., requiring 160,000 cubic yds. of material in construction. At the bottom of the slopes which are trimmed to 2 to 1 burnt clay toe walls 15 ft. high and of an average thickness of 25 ft. have been formed,

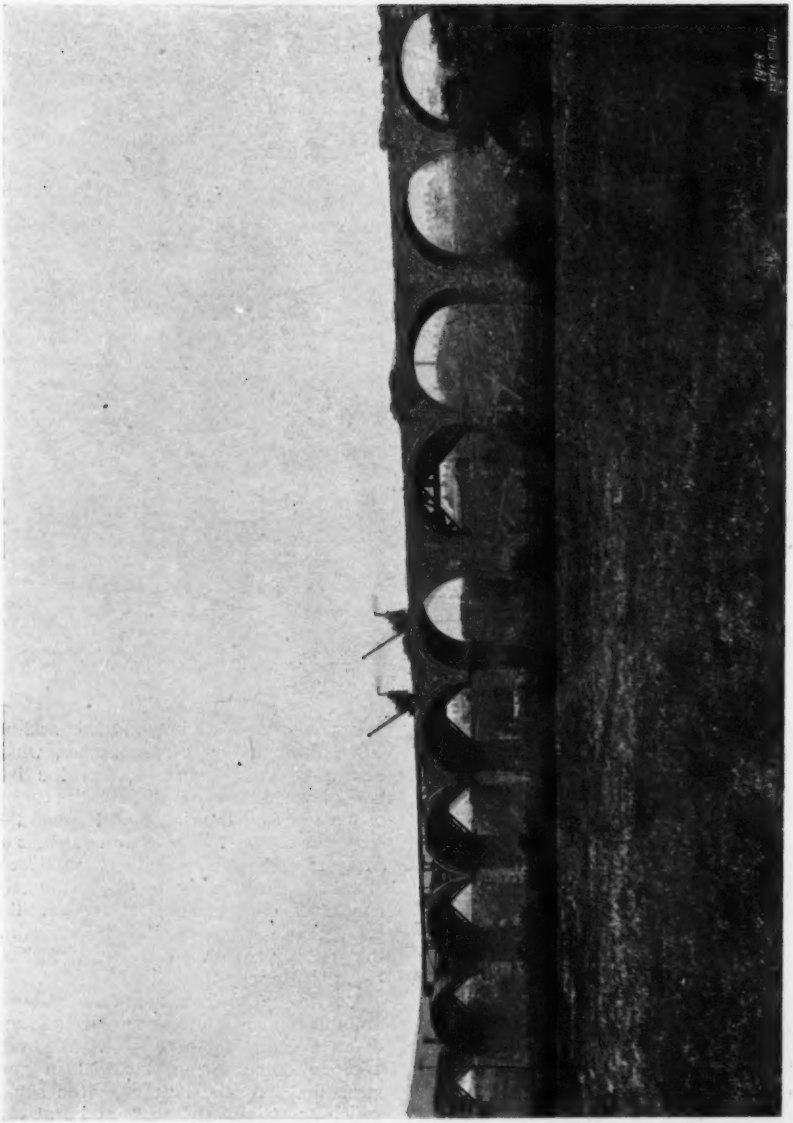


FIG. 1.—NEWTOWN VIADUCT, LOOKING S.E.

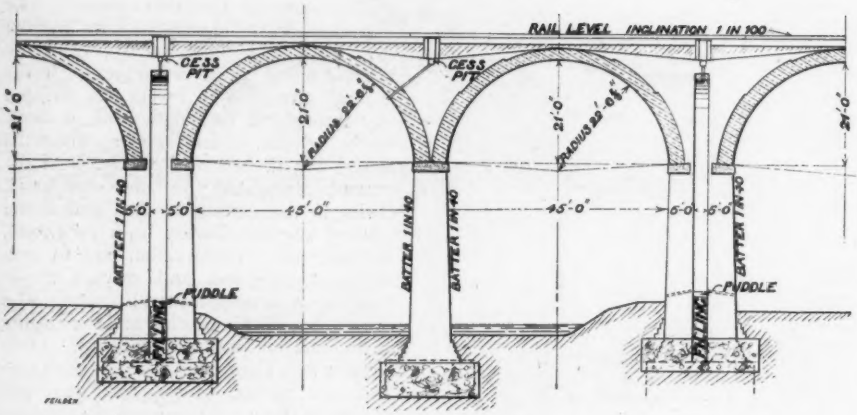


FIG. 2.—NEWTOWN VIADUCT.—LONGITUDINAL SECTION TAKEN THROUGH FOUR OF THE ARCHES.

(see Fig. 6.) At 38 chains the railway is crossed by an occupation road over-bridge, the abutments of which are built of snecked masonry, the roadway being carried by two steel main girders, with cross girders, brick arches between the latter forming the floor. The bridge has a skew span of 42 ft. 10¾ ins., while on the square the span is 40 ft., the angle of skew being 68° 50′. The distance between the rails and the underside of the girders is 14 ft. 3 ins., the width between the latter, or what is equivalent to the width of the roadway, being 21 ft. 6 ins.

From 37 to 41 chains the line is in cutting, from which was removed 10,000 cub. yds. of material, consisting chiefly of clay and sand. On the south side of the cutting a retaining wall of snecked masonry has been built, the height of which is 17 ft. above formation level. At 41 chains the line enters a covered way 90 yds. long, on a curve of 40½ chains radius, crossing under the Albion Road,

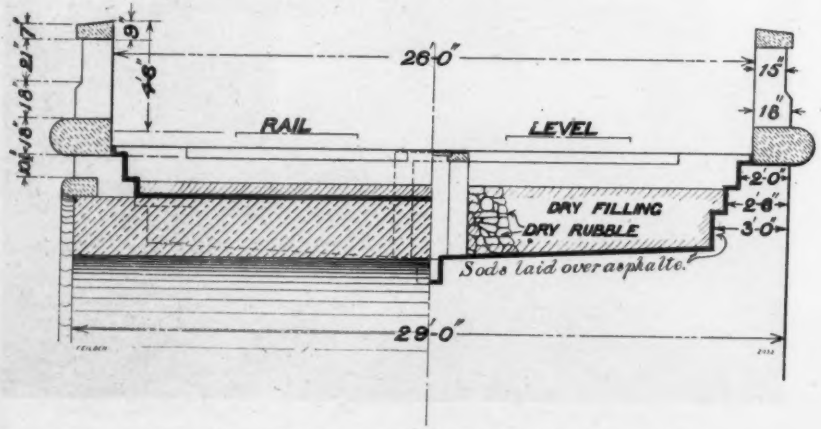


FIG. 3.—NEWTOWN VIADUCT.—DETAILS OF PARAPETS AND SPANDRIL WALLS.

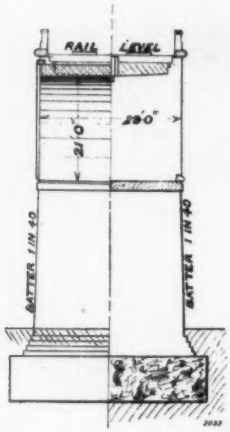


FIG. 4.—NEWTOWN VIADUCT, TRANSVERSE SECTION.—LEFT HALF TAKEN THROUGH CENTRE OF THE ARCH, AND RIGHT HALF THROUGH CENTRE OF THE PIER.

Newtown. It is built of brickwork with the exception of the faces, which are of snecked masonry with ashlar quoins. The span is 28 ft., the abutments 6 ft., and the arch 2 ft. 3 ins. thick, and owing to the wet and heavy nature of the ground, it was deemed advisable to invert the covered way throughout its length with a brick invert 18 ins. thick, under which is placed a 3 ft. bed of concrete. At the present time 40 yds. are completed. Owing to the cutting at each end of the covered way not having been excavated, the method of construction was to sink shafts at each end and drive a wagon heading on formation level between. The completion of this heading and the cutting at the east end was simultaneous. 18 ft. lengths were then started, one at each face and one in the centre, and on completion of these work proceeded from four faces. The excavation was commenced on the surface, the loosened earth being deposited into wagons in the heading through shoot holes.† [On completion of the excavation the concrete and brickwork material were lowered into the hole by means of a steam crane. On emerging, the

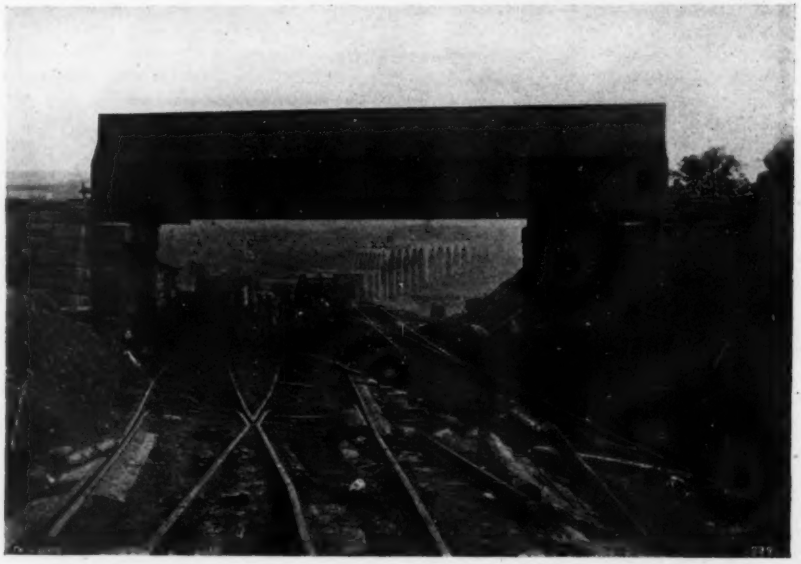


FIG. 5.—NEWTOWN BRIDGE AND VIADUCT, LOOKING S.E.

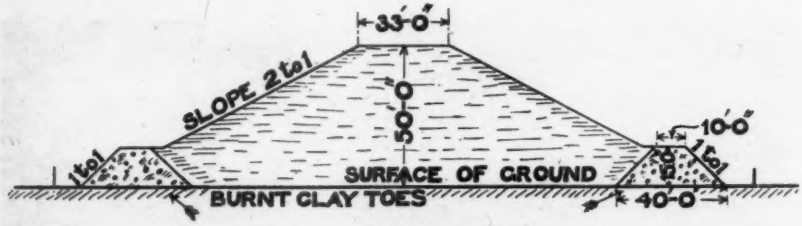


FIG. 6.—DETAILS OF SLOPES AND BURNT CLAY TOES.

line is again in cutting, the excavations, which were responsible for 30,000 cub. yds. of material, being chiefly in clay and sand. On the south side of the cutting a retaining wall of snecked masonry on a concrete foundation has been erected for a distance of 3½ chains. It is 27 ft. in height above formation level, and of an average thickness of 10 ft., and is succeeded for a further distance of 3 chains by a surcharged wall with a height of 10 ft. above formation level and an average thickness of 6 ft.

Some difficulties were encountered in sinking for the foundations of this wall, as there is a large cotton-spinning mill (Brunswick Mill) in the immediate vicinity; and, moreover, the excavating operations had to be taken through a bed of running sand 7 ft. thick, thus rendering a settlement of the mill imminent had not great precautionary measures been taken. The excavation for the high part of this wall was taken out in trenches 30 ft. in length, 18 ft. wide, and 37 ft. in depth, the latter being the depth of the foundation below the surface, this being rendered necessary owing to the above-mentioned bed of running sand.

At 58¼ chains a ravine is encountered, over which it is intended to erect a masonry bridge of three skew arches, the spans of which are to be 25 ft. each on the square and 27 ft. 7 ins. on the skew.

From 60 to 68 chains the line again enters on an embankment requiring 86,000 yds. of material to build. This bank had to be tipped on very side-long and treacherous ground, consisting generally of boulder clay with occasional thin beds of sand. On the high side of this bank and the next cutting, 50 ft. above the line and an average distance of 60 yds., is the Peak Forest Canal, while on the other side, 90 ft. below and 120 yds. away, runs the river Goyt. In order to prevent any slip taking place, rubble drains, 10 ft. wide and at an average depth of 9 ft. 6 ins., have been provided at intervals of 33 ft.

At the toe of the bank which was tipped first, a dry rubble wall, 12 ft. deep and 12 ft. thick, has been erected. The excavated material from the Disley Tunnel, which was of a solid and very satisfactory character, was used in tipping this bank.

Proceeding towards Manchester the line enters a cutting 9 chains in length, from which were removed 34,000 cubic yds. of boulder clay. Although the slopes are 2 to 1 it was deemed advisable to provide a heavy dry rubble wall at the toe.

A 6-ft. brick culvert, 100 ft. in length, is crossed by an embankment 2 chains in length, following which is another cutting from which was excavated 57,000 cubic yds. of clay and rock, and which is spanned at 1 mile 17 chains by a brick elliptical arch bridge carrying a farm road.

At 1 mile 28 chains the line, which is again on an embankment, is carried over a public road by a brick arch skew bridge, illustrated at Fig. 7. This bridge, which may serve as a type of the general style of underline brick bridge adopted, has a square span of 25 ft., that on the skew, 32 ft. 2 in., with a skew angle of 51 deg. The width between the parapets is 26 ft. Another feature to be distinguished from the illustration is that the wing walls on the northern side consist of dry rubble masonry. The gradient of the road at this point is very severe, viz., 1 in 6.

At 1 mile 30 chains there is a 4-ft. barrel

FIG. 7.—SKEW-ARCH BRIDGE OVER ROAD, AT 1 MILE 28 CHAINS.

culvert 270 ft. in length, and 5⅛ chains further on the line crosses Redhouse Lane by means of a 25-ft. span steel girder bridge. To enable this to be accomplished the public road had to be diverted for a length of 730 ft.

Passing in succession a three-span girder footbridge 175 ft. long, with a 6-ft. pathway between the girders and steps at both ends of the bridge; a 4-ft. barrel culvert 130 ft. long; a stream bridge 96 ft. in length and 10-ft. span,—the line enters, at 1 mile 63 chains, a cutting containing 13,000 cub. yds. of clay and shale, from which, at 1 mile 64½ chains, the Disley Tunnel commences.

This tunnel, which when completed will be the fifth longest in the United Kingdom, is 3,866 yds. in length, of which at the present time over 2,300 yds. are completed.

The tunnel is straight through its entire length, and is on a uniform gradient of 1 in 132. It traverses the lower and middle coal measures, and lies to the north-east of the Poynton Coalfield. The tunnel passes in succession under the Peak Forest Canal at 1 mile 68 chains, the Macclesfield Canal at 3 miles 33 chains, and the Macclesfield Committee Railway (North Stafford and Great Central Joint Lines), under which latter a 12-ft. brick arch bridge has been built to provide the necessary convenience for the contractors to get their material under the line.

There are 11 shafts, the deepest of which is 235 ft. (see Fig. 9), being on an average distance one from the other 16 chains. The two shafts at either end of the tunnel are temporary ones, and will be filled in when the works are completed. The permanent shafts, nine in number, are lined with 14 ins. of brickwork and have an internal diameter of 10 ft., and at the eyes (the junction of the shaft with the tunnel proper) the construction is entirely of blue brickwork in cement mortar.

At shafts Nos. 2, 3, and 4, more especially the last, considerable difficulty was attached to the sinking operations,

owing to the great quantity of water that was encountered.

The method of driving adopted was that of a bottom-heading throughout the length of the tunnel. This heading varied somewhat in size, being in some cases large enough to take an ordinary muck wagon and a specially constructed locomotive by Messrs. Manning Wardle & Co., a considerable quantity of material having to be taken out of the tunnel to make up the railway embankments. Between the shafts from the centre to the west end of the tunnel a 6-ft. heading was driven. This was used for ventilation and drainage purposes only, but when necessary it was widened so that the muck from the break-ups could be conveniently brought through it.

The tunnel is being built from each shaft, and in some cases from either one or two break-ups between the shafts. The tunnel is lined with brickwork in blue lias lime mortar faced with Staffordshire brindle bricks, the thickness varying, according to the nature of the ground, from seven rings with an invert in the boulder clay to four rings without an invert in the rock. (See Fig. 10.) The nature of the ground also determines the lengths in which the tunnel is being got out; they vary from 12 ft. to 21 ft.

Manholes 3 ft. 6 ins. wide and 18 ins. deep 66 ft. apart are provided on both sides of the tunnel. They are so placed that the manholes on the one side come midway between those on the other side. Four of larger dimensions, viz., 10 ft. by 10 ft. by 10 ft., are placed at half-mile intervals for the convenience of the platelayers in keeping their tools and materials in the tunnel.

The New Mills face of the tunnel (Fig. 8) will be constructed of masonry, and the wings thrown out at right angles to the railway slightly on the curve, both wings and face having a batter of 1 in 6. The Heaton Mersey face of the tunnel is nearly completed, and is built of brickwork. The wings are at

FIG. 8.—SOUTH END OF DISLEY TUNNEL.

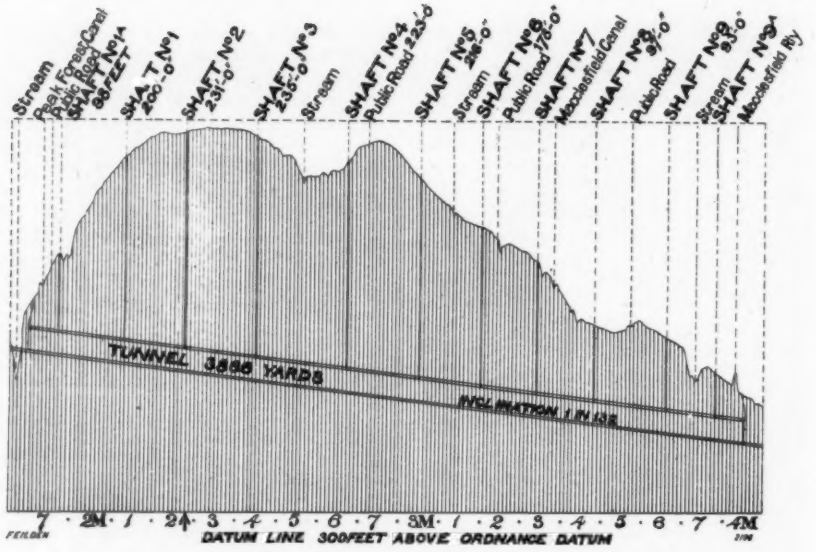


FIG. 9.—SECTION OF DISLEY TUNNEL (DISTORTED SCALE).

right angles to the railway, and are also on a slight curve, the batter in the case of both face and wings being again 1 in 6. The brickwork is coped with a heavy bull-nosed string course and square coping.

Emerging from the tunnel, the line enters a cutting which extends for a length of 50 chains, and from which 250,000 cub. yds. of material were removed. The greatest depth attained is 47 ft ; where the depth is 30 ft. or over, the slopes are trimmed to 2 to 1, and where it is under 30 ft. to 1½ to 1. On the south side of this cutting the main service-pipes that supply Stockport with water had to be diverted for a distance of 25 chains.

At 4 miles 8 chains Threaphurst Lane is carried over the line by a three-arch brick bridge, illustrated at Fig. 15. This view represents the bridge before the dumplings were removed ; trenches have been sunk in which were built the two central piers. These piers, which batter 1 in 40 on the four sides, are 4 ft. 9 ins. thick at springing level, and the abutments 7 ft.; the batter on the wings of the latter is 1 in 6. The span of each arch is 30 ft., with a rise of 14 ft. The appearance of the bridge has been greatly enhanced by the addition of a blue brick label 6 ins. by 15 ins. over the arches. The bridge also carries a stream across the cutting by means of a 2-ft. diameter cast-iron pipe.

Passing an accommodation bridge of two elliptical-arch spans of 28 ft. each, the line at 4 miles 50 chains is on an embankment of 150,000 cub. yds., at the Heaton Mersey end of which the Hazel Grove passenger station will be situated.

Works of only a very ordinary character intervene between this and 5 miles 3 chains, at which point the Norbury Viaduct, 230 yds. in length, commences. This important structure, carrying the rails at an average height of 35 ft. from the ground, is on a 1½-mile radius curve, and consists of thirteen openings. There are two girder spans ; the first, at the east end, crosses the Buxton and Manchester main road, and the second, at the west end, the Poynton and Stockport Road, the space between being spanned by eleven elliptical

brick arches of 33 ft. 4 in. span, 11 ft. rise, and 2 ft. 4½ ins. thick, resting on piers 4 ft. 9½ ins. thick at the springing, and having a batter on the four sides of 1 in 40. The centre span has three strut walls 3 ft. thick, thus making it act as an abutment. As in common with the other bridges on this line, the blue brick label greatly improves the appearance of the arches. Over the arches four recesses or manholes — 3 ft. 6 ins. wide and 16 ins. deep —on each side have been built in the brick parapets.

Of the two girder spans, the first, over the Buxton Road, Fig. 13, is 54 ft. span on the square, 120 ft. 5½ ins. skew span, with a headway of 19 ft., the angle of skew being 26 degs. 38 mins. The steelwork, weighing 370 tons, consists of five plate girders, with cross girders, rail-bearers, and flooring. The two outside girders are 142 ft. long and 11 ft. deep, and act as parapets. The three main girders under the rails (see Fig. 14) are 136 ft. long, 10 ft. 6 ins. deep, and of similar section, being so spaced that the weight they are designed to carry is equally distributed over them. They are connected by

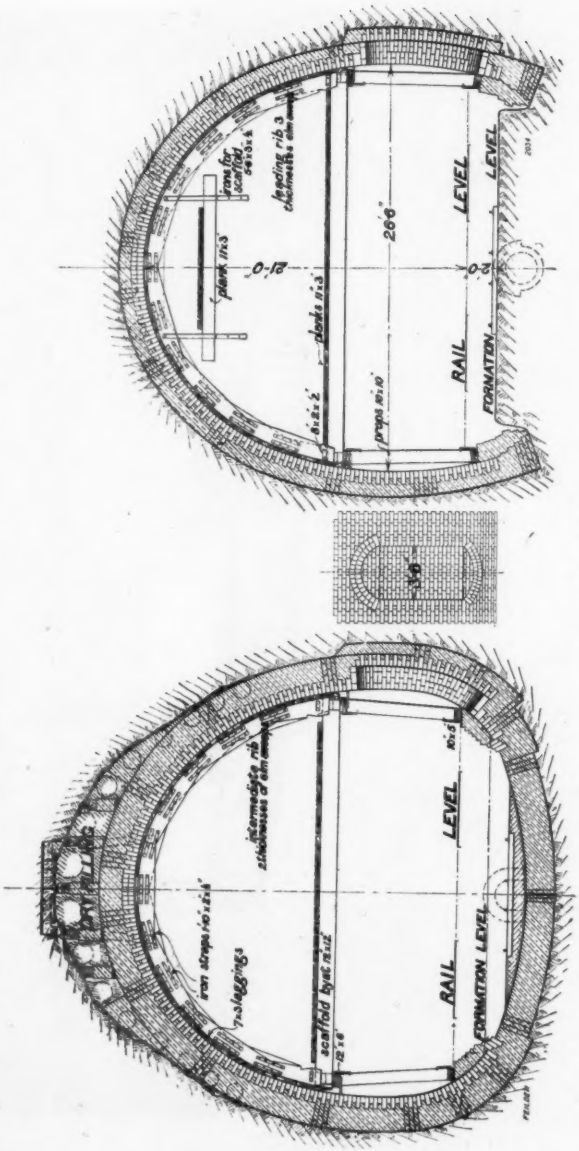


FIG. 10.—DISLEY TUNNEL.

SECTION OF TUNNEL WITHOUT INVERT (IN ROCK).

SECTION OF TUNNEL WITH INVERT (IN SHALE OR CLAY).

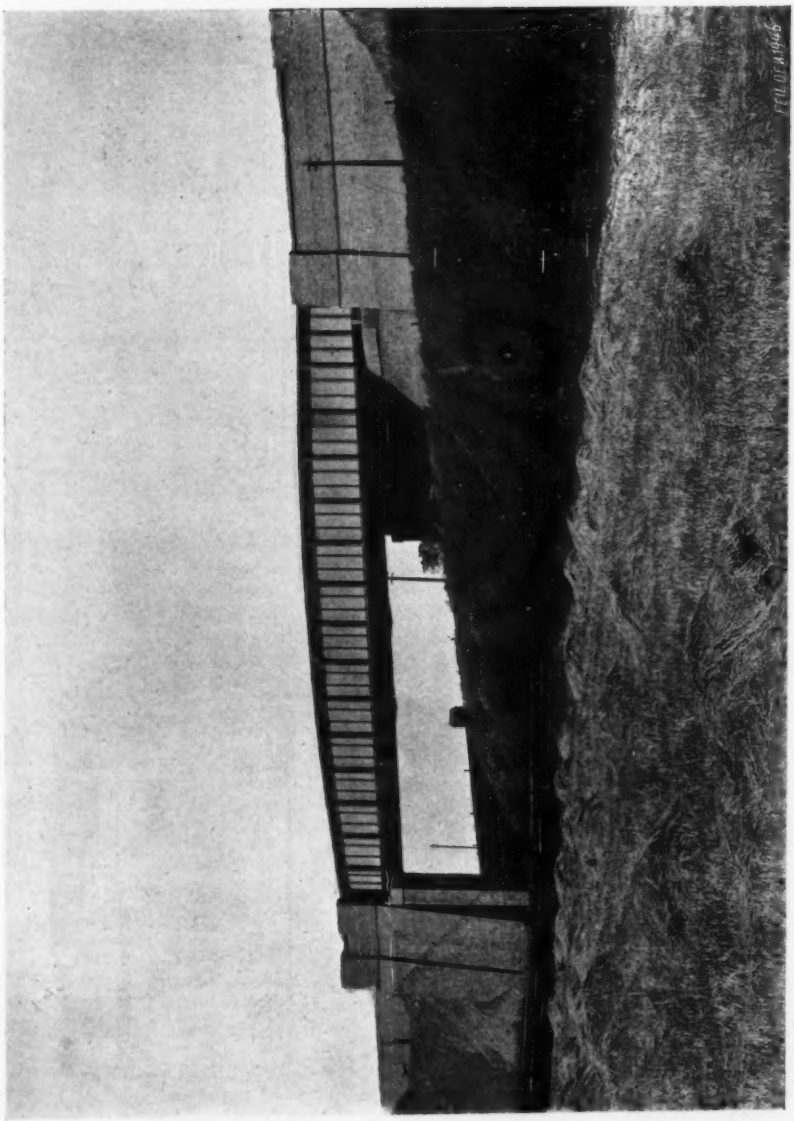


FIG. 11.—BRIDGE OVER THE BUXTON AND STOCKPORT BRANCH OF THE L. AND N. W. RAILWAY.

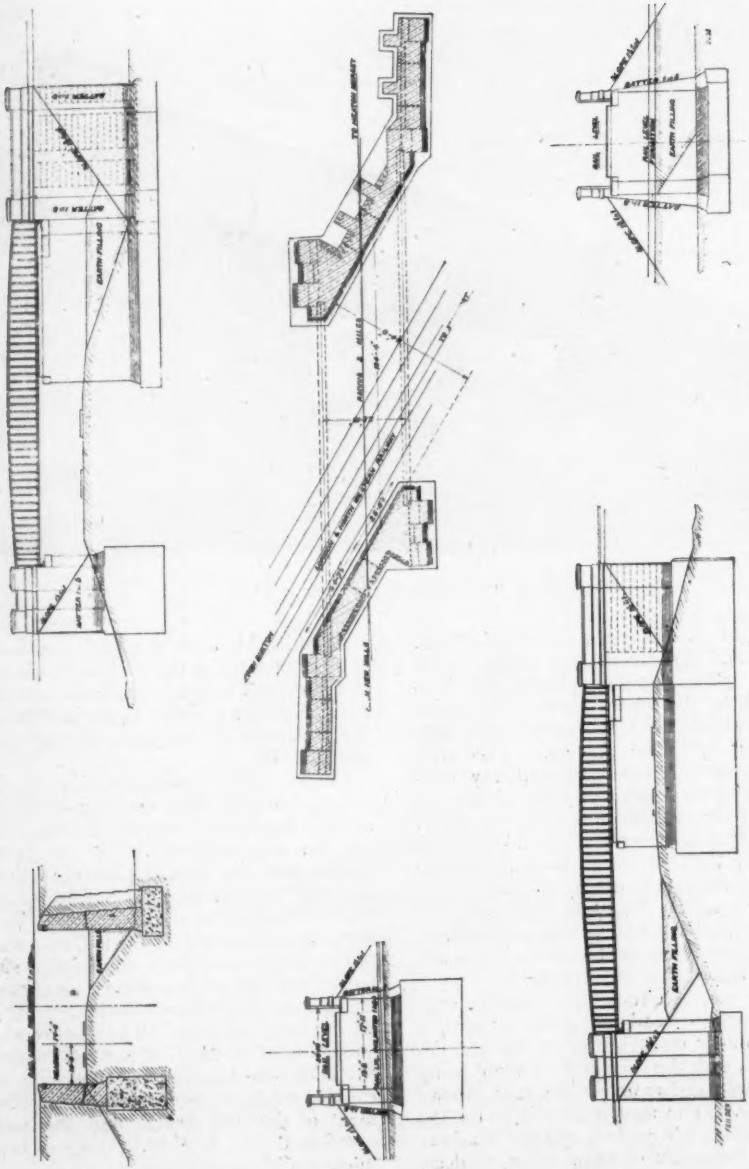


FIG. 12.—DETAILS OF BRIDGE OVER BUXTON AND STOCKPORT BRANCH OF L. AND N. W. RAILWAY.

FIG. 13.—NORBURY VIADUCT; BUXTON ROAD SPAN.

cross girders 5 ft. 4 ins. apart and 18 ins. deep, and by curved floor plating $\frac{7}{16}$ in. thick. The parapet girders are connected to the main girders by gusset stays, whilst the main girders are held together by lattice bracing. The main girders are supported on ordinary cast-iron knuckle rockers, held down by $1\frac{1}{2}$-in. bolts to bedstones 2 ft. 6 in. thick. The brick abutments are 9 ft. thick, and that on the east side is strengthened by two counterforts 6 ft. by 5 ft.; whilst the west abutment, together with the east abutment of the first arch span, form one big hollow block of brickwork, the space inside being filled with rubble.

The second girder span—namely, over the Poynton Road—weighing 95 tons, is of a similar construction to that just described, with the exception of there being four main girders under the rails instead of three. The square span is 57 ft., the skew span 59 ft. $3\frac{1}{2}$ ins., and the headway 25 ft., the angle of skew being 74 degs. The brick abutments vary little from those described for the Buxton Road span.

A noticeable feature of the brickwork of the abutments at the back of the girders of both spans is that it has been built so as to afford easy access to all portions of the steelwork for purposes of inspection and painting.

Contract No. 1 terminates in a bank of 150,000 cub. yds., dividing which is another important structure, illustrated in Fig. 11, viz., a girder bridge of 54 ft. square span and 104 ft. 4 ins. skew span, carrying the line over the Stockport and Buxton Branch of the L. & N.W. Railway. The new line is carried by means of two hog-backed plate main girders supported on brick abutments, the cross girders, rail bearers and flooring being of an ordinary character. The span is wide enough to allow the L. & N.W.R. to place two additional lines of way alongside the existing roads, the space between the abutment of the new bridge and the bank carrying the L. & N.W.R. having been filled in with earth.

Considering that no large town is traversed by this length, constituting the first

contract, which has been under the care of Mr. H. P. Miles, A.M.Inst.C.E., the works have been of a heavy character, and, moreover, such as would have perhaps awakened a much wider interest outside professional circles in the pioneer days of railway engineering than is the case today, when we are accustomed to look upon the completion of an important section of a new line with as much complacency as though it was the most ordinary thing in the world.

Contract No. 2 commences at 5 miles 36 chains, and ends at 9 miles 57 chains by a junction with the existing Manchester Line at Heaton Mersey. At 9 miles, a curve $\frac{1}{4}$ mile long connects the new line with the Cheshire Lines Railway to Liverpool. This length is under the charge of Mr. G. C. McDonald, M.Inst.C.E., and the contract was let in March, 1899, to Mr. Henry Lovatt of Wolverhampton.

The point of commencement is practically at the foot of the hills through which the first portion of the railway runs. From here the whole country side forms an almost unbroken slope to the valley of the Mersey 4 miles away; falling 127 ft. in that distance. The soil throughout is almost entirely alluvial, consisting for the most part of sand, gravel, and loamy clay. This material was very good stuff to shift, and from the above description of the district it will be gathered that the earthwork on this section was of a light character. There was, however, some very heavy work in the way of bridges, the principal being a viaduct over the river Mersey presently to be described.

The line almost throughout the 4 miles runs in shallow cutting, in consequence of which nearly all the bridges are "over" ones with heavy approaches on each side. In fact, of the 19 bridges on the contract only three are under the line (exclusive of the viaduct). The chief of these "under" bridges is at the beginning of the contract —a girder span of 36 ft. over the Chester road. Three main girders were used, in order to save headway, the cross girders by this means being only 12 ft. span, and shallow in proportion; the centre main girder rises 3 ft. above rails in the six foot.

The general type of arched over-bridges, of which there are five in the next mile and a half, is well shown by the photograph

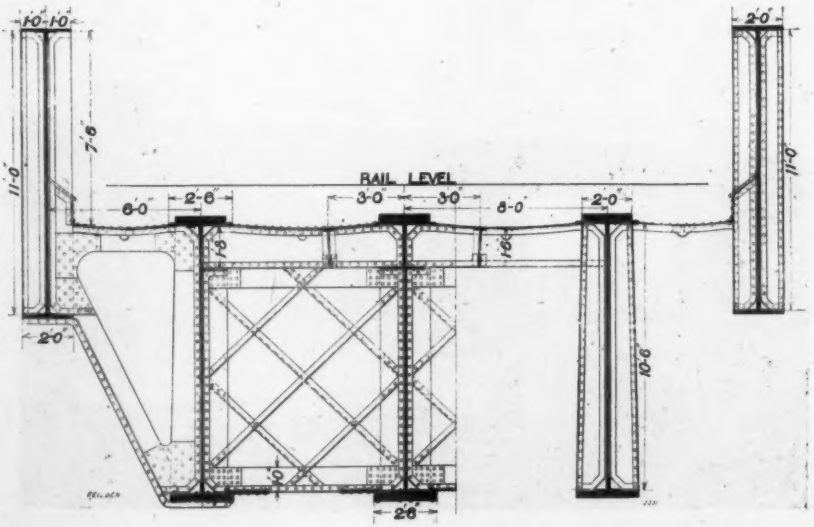


FIG. 14.—NORBURY VIADUCT, TRANSVERSE SECTION OF SPAN OVER BUXTON AND STOCKPORT BRANCH RAILWAY.

FIG. 15.—BRIDGE CARRYING THREAPHURST LANE.

FIG. 16.—BRIDGE UNDER THE CHEADLE BRANCH OF THE L. AND N. W. RAILWAY.

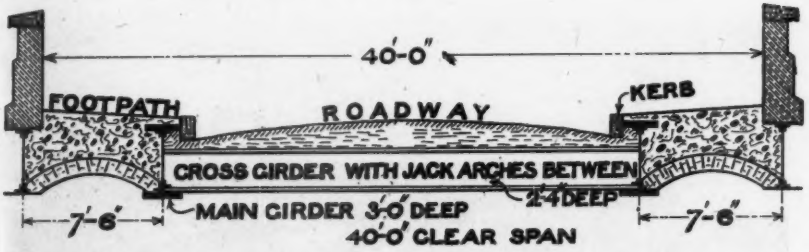


FIG. 17.—CROSS SECTION OF SUPERSTRUCTURE OF JACK-ARCH BRIDGE ADOPTED IN CASES WHERE HEADWAY IS LIMITED.

Fig. 18. These consist of two elliptical arches 28 ft. span, 8 ft. rise. The second arch is built with a view to future widening ; the only addition required when this is done being the wing walls. The foundations of the buried abutment are taken down to the same level as the other one with the same object. It may perhaps be here remarked that throughout No. 2 contract sufficient land has been taken for four lines of rails, although only two are at present being constructed. All the bridges are also built in a similar manner to those described above, so as to be easily widened hereafter at a minimum of expense. Considerable difficulty was met with in sinking for several of the foundations of the bridges in the first two miles, owing to the presence of water, which where sand and gravel were encountered fairly boiled up in the bottom of the trenches.

At 7 miles 58 chains Adswood Road is carried over the line by means of a girder bridge, having two spans as in the arched bridges. The superstructure consists of longtitudinal girders spaced 5 ft. apart with brick jack arches between ; the whole levelled with concrete so as to just cover the top flanges of the girders. A trough is formed for gas and water pipes across the bridge by leaving out one jack arch and using floor plates across the bottom flanges of two of the girders. This was the general form of construction employed for road bridges where arches were inadmissible from want of headroom or other causes.

Soon after this road the line passes under the main line of the London and North Western Railway from Manchester to Crewe, and half a mile further on under the same company's Cheadle branch. Both these were very heavy bridges, but as they were identical in construction (except that there were three roads on the main line and only two on the branch) it will be sufficient to describe the former. It consists of two spans 26 ft. on the square, with continuous girders, one under each rail, and two parapet girders. The spaces between the girders were filled by brick in cement jack arches, concreted over the top as in the road bridges. The North Western runs on an embankment at this point, and each abutment and the pier were built in 9 ft. trenches driven through the bank ; the brickwork in each one being built up before the excavation for the next one was started. As owing

MR. G. C. McDONALD, M.INST.C.E.,
Resident Engineer, Contract No. 2.

FIG. 18.—ROAD BRIDGE AT 7 M. 43 C.—GENERAL TYPE OF OVER-BRIDGE.

to the railway overhead these trenches were only accessible from the ends, the ordinary timbering with polling boards and frames some 3 ft. 6 in. apart vertically was inadmissible. The following method was therefore adopted: Instead of polling boards, 3-in. planks were used laid horizontally with half timber "soldiers" or vertical wallings, 7 ft. long; a cross strut was placed at each end of these "soldiers." An opening was thus left through the frames 6 ft. 6 in. by 5 ft. 6 in. for the full length of the trench, enabling a man to get in and out with a barrow. The North Western lines were carried over the trenches on heavy timbers, two under each rail, extending across the whole length of the bridge. These were put in before the bridge was started, and were not again touched until finally removed to make way for the girders. The "dumplings" between the trenches were not removed until the girders were in place, and the whole bridge complete. It is satisfactory to note that no interference was caused to the traffic during construction, the trains not even being slackened in speed—except of course on the two Sundays when the girders were erected.

A photograph of the bridge under the Cheadle branch is shown in Fig. 16. It may be mentioned that the abuts and piers of both the London and North Western Railway bridges have been built to the full height, wide enough for two more roads to be carried across.

The next work of any importance is at Cheadle Heath, were two of the main roads out of Stockport are carried over the station yard. Both these are girder bridges with jack arches, but the larger of the two (Edgeley Road), consisting of three 26 ft. openings at an angle of 41 deg., is of somewhat unusual construction, owing to lack of headway. A cross section of the superstructive showing the method adopted is given in Fig. 17.

About a quarter of a mile further on we come to the most important work on the length, and with the exception of the Disley Tunnel, on the whole of the new line, viz., the viaduct over the river Mersey.

This is composed of four girder spans, three of 78 ft. over the river, and one of 102 ft. over the Cheshire Lines Railway (Stockport to Liverpool), immediately beyond. The height of the rails above the river is 50 feet.

The shore abutments are of brickwork with cement concrete foundations, and were carried down to the red sandstone rock which occurs all along the Mersey Valley in this neighbourhood. It was found at this point some 12 to 15 ft. below the surface of the ground.

The river piers consist of cast-iron cylinders filled with brickwork in cement mortar, two to each pier with cross bracing between them. These cylinders are six feet in diameter above the river bed widening out to 10 ft. diameter below, They were sunk to a depth of 15 ft. below the river bed well into the rock. The river at this point is very swift flowing, with a normal depth of water of two or three feet only. It rises and falls, however, with extreme rapidity, and after heavy rain often attains a depth of 10 ft. or more in a few hours. It was tried at first to sink

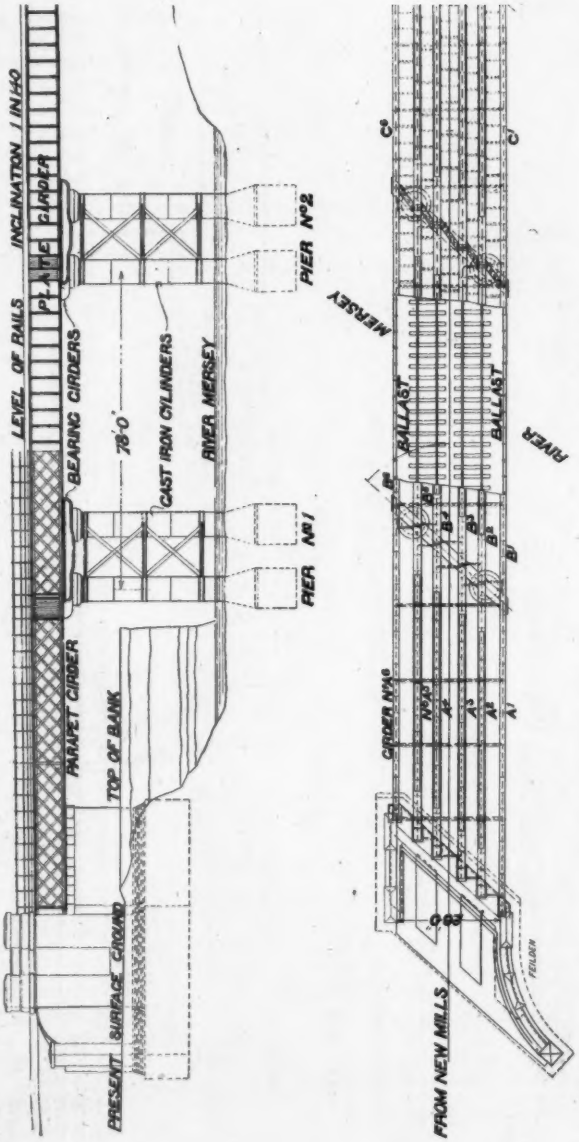
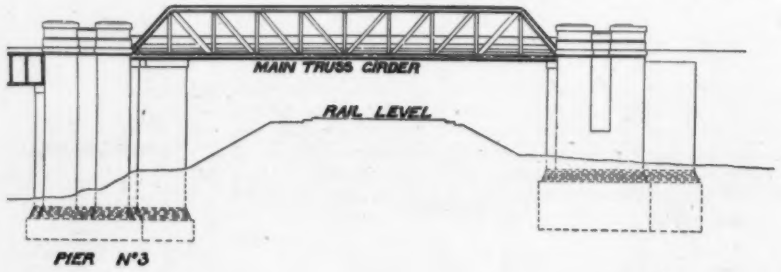
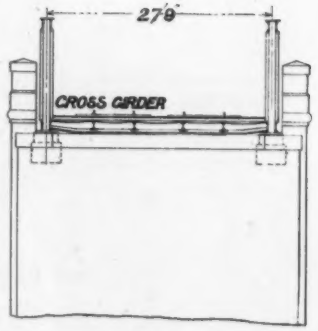


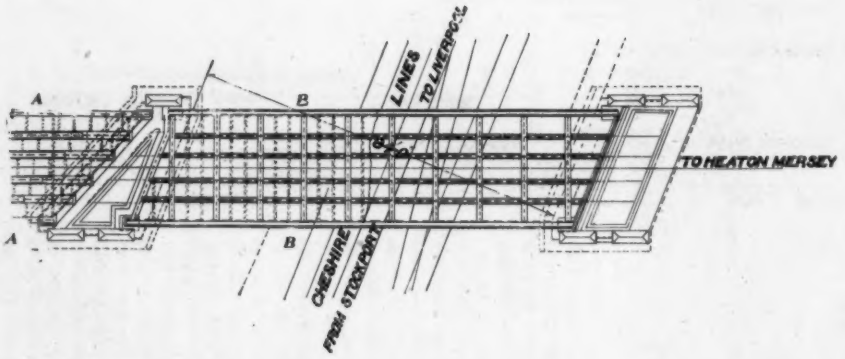
FIG. 19.—MERSEY VIADUCT, CENTRAL PLAN AND ELEVATION OF THE RIVER SPANS.

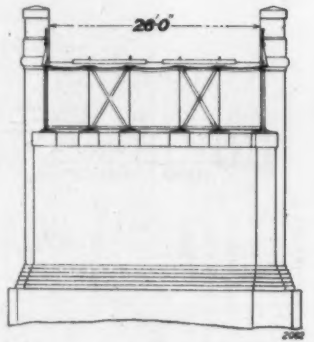
GENERAL PLAN AND ELEVATION.





CROSS SECTION BB.





CROSS SECTION AA.

FIG. 20.—VIADUCT OVER THE RIVER MERSEY.—GENERAL PLAN, ELEVATION AND CROSS-SECTIONS OF THE SPAN OVER THE CHESHIRE LINES.

the cylinders in the open by pumping out the water from inside, but the bottom of the river being gravel overlying the rock it was found impossible to get the bottom dry. Recourse was therefore had to the compressed air system, and all four cylinders were sunk without any difficulty. The average pressure required to keep the water out during the normal condition of the river was 12 lbs. per sq. in. As soon as the required depth for the foundation was reached, five feet of rich cement concrete was laid in the bottom, and allowed to set before the air pressure was taken off. This acted as a seal against the water, and when the air lock was removed the cylinders remained perfectly dry inside. The brickwork was then built inside to the required height. A circular bedstone was placed on the top, to receive the girders, slightly smaller in diameter than the cylinder, so that all the weight of the bridge should be carried on the column of brickwork and not on the cast-iron skin. Across the top of the two columns forming each pier a very heavy bearing girder, Fig. 21, was placed to carry the ends of the main girders.

The superstructure of the three river spans consists of four main plate girders, one under each rail, and two outside lattice parapet girders.

These girders are 7 ft. 9 in. deep, and are connected together by diaphragms and cross braces. The whole bridge is decked with dished floor plates riveted to the top flanges of the girders. Ample provision has been made for expansion. Each span, which is complete in itself, is bolted down to the bearings at one end, and is free to move on sliding plates at the other. A space of one inch is left between each

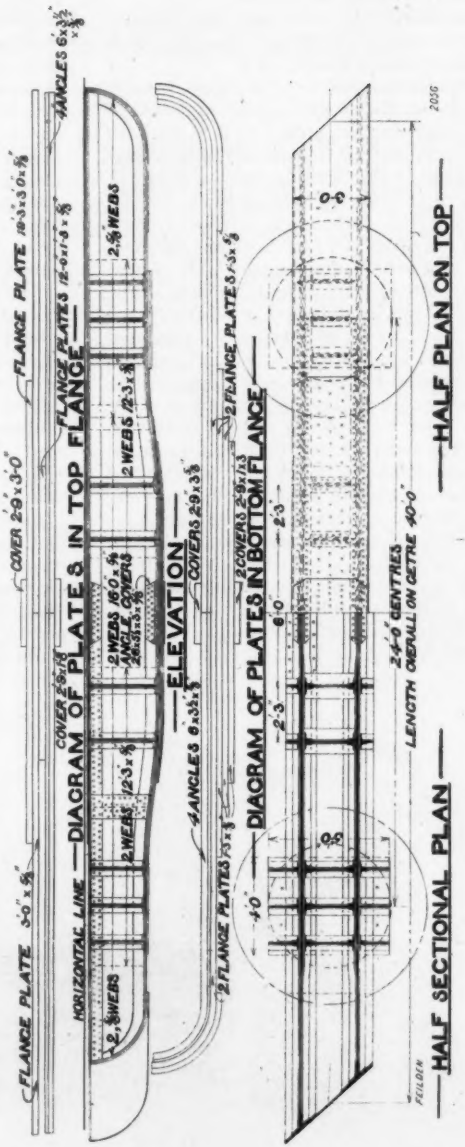


DIAGRAM OF PLATES IN TOP FLANGE
ELEVATION
DIAGRAM OF PLATES IN BOTTOM FLANGE
HALF SECTIONAL PLAN
HALF PLAN ON TOP
FLANGE PLATE
COVER
ANGLES
2 WEBS
2 FLANGE PLATES
2 COVERS
FLANGE PLATES
2 WEBS
ANGLES
COVERS
2 FLANGE PLATES
2 COVERS
2 WEBS
ANGLES
2 WEBS
2 FLANGE PLATES
HORIZONTAL LINE
2 WEBS
2 WEBS
2 WEBS

span, and a cover plate fixed over the joint with slotted bolt holes.

Between the river and the railway, which cross at different angles, is a large wedged shaped brick pier.

The railway span is 94 ft. on the square, 102 ft. on the skew; and is composed of two main trussed girders 13 ft. deep, with cross girders, rail bearers and floor plating between. The main girders are 113 ft. long, and weigh 42 tons each.

The river girders, which weigh 17 tons each, were lifted on to the piers complete, but the main railway girders were riveted up on a temporary staging *in situ*. The total weight of steelwork in the viaduct is 570 tons. The ordinary cross sleepered road is laid across the viaduct, and is ballasted with clean granite chippings.

About ¼ mile beyond the viaduct the line joins the existing railway at Heaton Mersey, being carried for this distance on a high embankment. A junction is formed with the Cheshire Lines, before crossing the Mersey, by means of a short curve.

There will be one station on this length, viz., at Cheadle Heath, which will be a large and important one, as here the trains will be split up into the various portions for Manchester and Liverpool. The local Manchester traffic has also grown to such an extent in recent years that considerable delay is caused by want of suitable accommodation for the trains. A large area is therefore being laid out at Cheadle Heath for storing and marshalling these local trains, and amongst other conveniences to be provided will be a goods shed and several long coal-sidings.

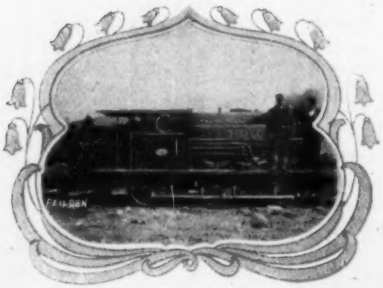
The whole of this station yard is in cutting, varying from 6 to 16 ft. in depth, and has involved the removal of 213,000 cub. yds. of earthwork. There are about 2¼ miles of siding accommodation provided.

At Bramhall Moor Lane (6 miles 5 chains) a lie-by siding, one or two coal-sidings, and a goods shed will also be provided, although no passenger station will be built there at present.

The line throughout is laid with the Midland Railway Company's standard road, the rails of which are 36 ft. long weighing 100 lbs. to a yard, with 14 sleepers to a length.

From Hazell Grove to Heaton Mersey land has been taken for four roads, but at present the line is only being constructed for two. The over-bridges, however, are being built with two double spans, so as to be widened hereafter with the minimum of expense.

C. L. Allen



Power Hammers.

By ERNEST SAMUELSON, M.Inst.C.E., M.I.Mech.E.

Mr. Samuelson was born in 1856, and educated at Kensington Grammar School and King's College, London. He served for two years in the drawing office at Earle's Shipbuilding and Engineering Co., Hull, then for a short period at Greenwood & Batley's, Leeds, after which he joined the firm of Samuelson & Co., Banbury, in 1878, taking in 1883 full management of the works.

The firm's speciality is Harvesting Machinery: but Flour Milling Machinery was added to their products by Mr. Samuelson in 1882, and Roots' Blowers and Exhausters in 1888, as well as Engines for same, and Longworth's Power Hammers in 1891.

Mr. Samuelson was elected a M.I.Mech.E. in 1881, and an Assoc. M.Inst.C.E. in 1882, being transferred to full membership in 1893.

Whilst economy in power is engrossing the attention of all who are engaged in the manufacturing interests in this and other countries, and the tendency is to concentrate steam power in one spot, and convey its energy either by means of electrical power or by shafting and belts, or by a combination of both, to the tool, we are brought to the consideration of, amongst other things, the advantage in the use of power in place of steam-hammers, for such purposes as stamping light articles between dies, drawing down, and general work of a light nature, where smaller sizes of steam-hammers show an excessive consumption of steam in proportion to the work done; belt-driven power or pneumatic hammers can also be advantageously used for riveting purposes.

The author proposes in the following lines to describe primarily one form of pneumatic hammer capable of being driven by belting from a main line of shop shafting, or direct by means of a motor, and only to touch upon the various forms of such hammers which are upon the market at the present time, as he desires this article to be the means of drawing the attention of manufacturers to the

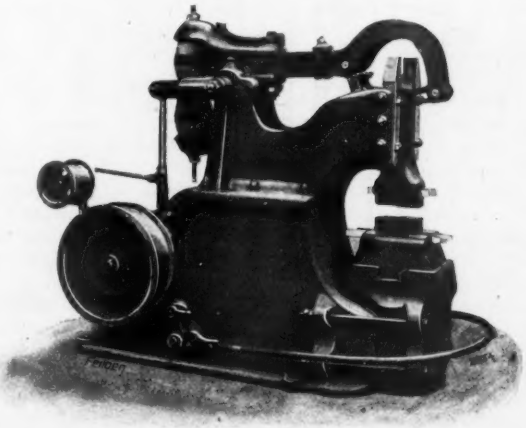


FIG. 1.—THE "BRADLEY" UPRIGHT CUSHION STRAP HAMMER.

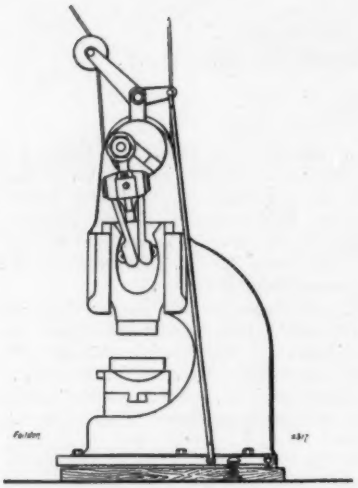


FIG. 2.—THE "BEAUDRY" CHAMPION POWER HAMMER.
The elasticity is obtained by the combination of the spring arms with the rollers rolling up and down in the concaved curved track in the head.

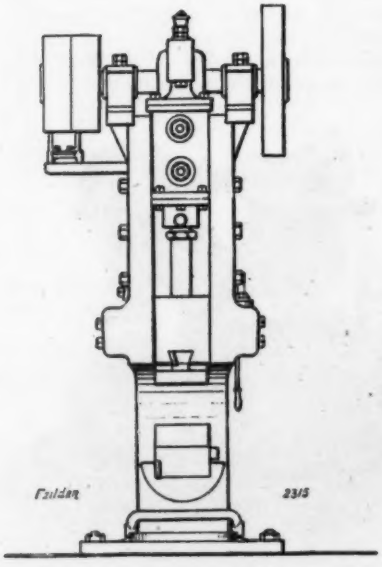


FIG. 3.—300-LB. "HACKNEY" HAMMER.

advantages in the use of such a class of tools, rather than to make any comparison as to their various merits as compared with each other, as made by different manufacturers, owing to his being more especially interested in the "Longworth" Hammer; and will feel that he has made a step in the right direction of progress if he can arouse the interest of manufacturers in this country sufficiently to cause them to look into this subject and compare and judge for themselves as to their relative merits.

The points to be considered mainly in the use of such a tool are—first, its economy in the power necessary for driving it.

Secondly, its degree of perfection in the control of the blow.

Thirdly, its regularity of speed under varying strength of blows, and consequent rapidity of production of work.

Fourthly, its simplicity of design and ease and cost of repairs or replacements of worn parts, and

Fifthly, its prime cost, which must be considered not only in conjunction with the saving in power or steam necessary to drive it, but also with the general cost in wear and tear of parts and belting used, when drawing conclusions as to the merits of different designs of power-hammers.

There are several of these at the moment upon the market, some of which vary the intensity of the blow by tightening or slackening the driving belt upon the pulley by means of a jockey pulley. This, of course, means wear and tear of belting. In this class of hammer elasticity is given to the blow by means of a spring connection between the tup and the driving-pulley, and they are several in number, amongst them as being a typical hammer may be mentioned the Bradley Upright Cushion Strap Hammer, Fig. 1. From the illustration it will be seen that the head or tup is guided vertically, and held and operated by means of a leather strap suspended from the curved helve or arm. This arm oscillates on a central pivot, and is connected to the driving shaft by means of an eccentric and strap, to which motion is given by means of the belting. The action of the tightening,

or jockey pulley, is clearly shown in the illustration, and needs no description. Thus the speed or number of blows per minute, and the force of same, depend entirely upon the amount of tension on the belt and grip upon the pulley, which is regulated by the attendant from the front of the machine. Rubber cushions are also provided in this case, as shown in the illustration, to absorb shock and jar to the working parts, and to add to the force of the blow.

Another form of hammer is shown in Fig. 2, being made by the Beaudry Co., of Boston, U.S.A. In this design a jockey-pulley is provided as in the previous case, but the elasticity of the blow is obtained by the combination of the spring arms with the rollers, which work up and down in the concave curved track in the hammer tup or head.

Others effect the same object by putting more or less friction upon the falling tup and tool by means of wedge pieces or brakes, placed under the control of the attendant, an air cylinder also being used. Whilst another method consists in the use of an air cylinder in which the piston works, having air valves at the top and bottom, which are controlled as to the amount of air which they admit or allow to escape from the cylinder by means of wedges, which limit their amount of lift or opening, and so give the requisite amount of air cushion above and below the piston, but all this latter type absorb power due to this friction, and are liable to rapid wear on those parts subject to same.

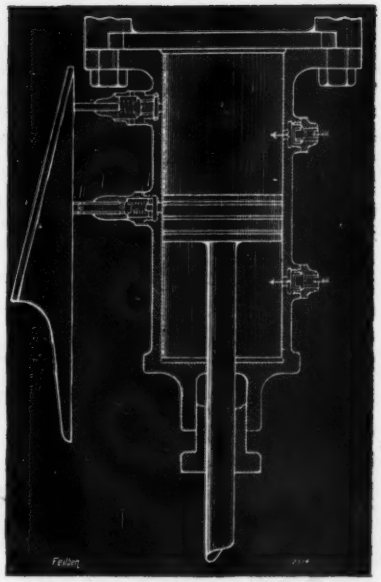


FIG. 4.—SECTIONAL VIEW OF CYLINDER, 200-LB. "HACKNEY" HAMMER, SHOWING PISTON VALVES, ETC., AND RELATION OF WEDGE TO VALVES AND POSITION OF PISTON WHEN HAMMER IS NOT IN OPERATION.

In the 200-lb., and all sizes above, there are two controlling valves.

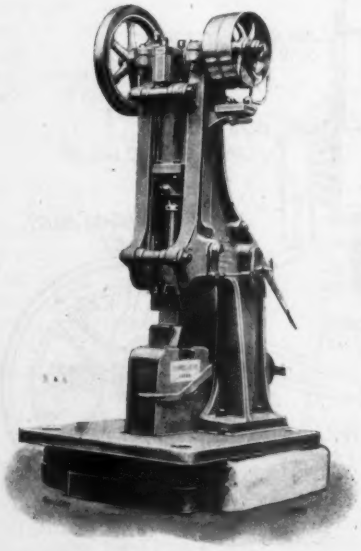


FIG. 5.—A SIMILAR TYPE OF HAMMER TO THE PRECEDING, BY MESSRS. GREENWOOD AND BATLEY, LTD.

Fig. 3 illustrates a hammer of this latter type made by The Hackney Power Co., of Cleveland, Ohio. From this illustration it will be seen that the air cylinder works freely up and down between the standards in suitable guides, and is driven by means of a crank and slide block, which is coupled to the top cylinder cover. The inlet air valves are shown clearly at the top and

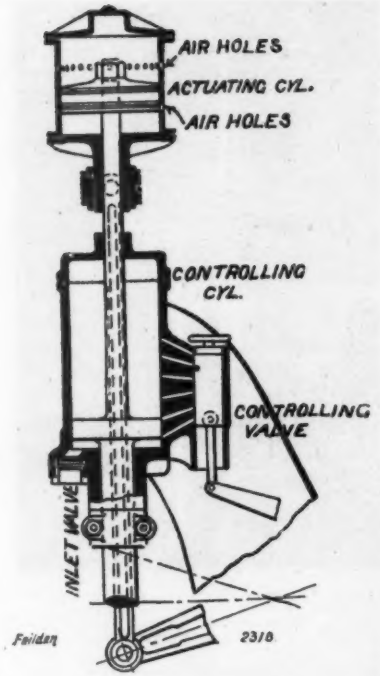


FIG. 6.—SECTIONAL VIEW ILLUSTRATING PRINCIPLE ON WHICH THE "LONGWORTH" POWER HAMMER IS BUILT.

bottom of the cylinder, whilst the outlet valves are shown in Fig. 4, controlled by a wedge piece moveable at the will of the attendant.

A similar type of hammer is illustrated in Fig. 5, manufactured by Messrs. Greenwood and Batley, of Leeds. These latter, as well as the "Longworth" Power Hammer, may be termed "Pneumatic" Power Hammers, in contra-distinction to those first described, which do not employ an air cylinder at all, but this term "Pneumatic" must not be misunderstood to imply that the Hammer is worked solely by pressure of air, but only in so far as the compression of the air on the top and bottom of the piston, due to its reciprocating movements produced by the crank motion, or other driving mechanism, assists in intensifying the blow, or falling weight of the tup, and a description of the various forms of the "Longworth" Hammer with the accompanying diagrams, will serve to make clear to the reader this latter class of hammer, which, whatever may be said against it, on account of first cost, as compared with the first mentioned type of hammer, with belt drive and strap connections, has the advantage of a wider scope of work, and thereby becomes a more efficient and economical tool in the long run.

The "Longworth" Power Hammer forms a distinct departure from all previous modes of construction, as instead of varying the intensity of the blow by means of a movable fulcrum or frictional brake upon some of the moving parts of the hammer,

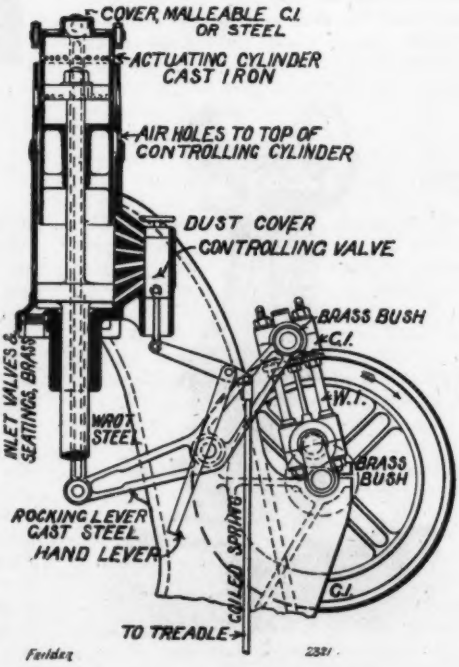


FIG. 7.—"LONGWORTH" POWER HAMMER: GEARING FOR 3-CWT. HAMMER.—SECTION.

it is regulated by means of a cushion of air rendered variable in volume under the piston in a controlling cylinder in a simple manner by means of an air valve under the control of the attendant, and this air valve is subject to no more wear than is occasioned by the simple sliding movement given it by the attendant as he from time to time raises or lowers it, so as to open one or more of the air-ports in the controlling cylinder.

Fig. 6 is a sectional view, which serves to illustrate the principle upon which the hammer is built. It will be seen that the hammer consists of the usual piston, piston-rod and tup, but the piston-rod is prolonged upwards and carries a supplementary or second piston working in a second cylinder. The lower cylinder merely acts as a "controlling" cylinder for regulating the intensity of the blow, which is effected by means of a series of air-ports communicating with the lower cylinder and the outside atmosphere, which ports can be opened or closed, one or more at a time, by a simple cylindrical plug-valve, under the control of the attendant, by means of a hand- or foot-lever, Fig. 7. The top piston works in a second or "actuating" cylinder freely in a vertical line, and a double series of air-holes communicating freely with the atmosphere is drilled round this cylinder to regulate the cushion of air in the same, according to the nature of the work to be done under the hammer, and to prevent the piston striking the covers; this cushion also assists in intensifying the blow and in lifting the tup on its upward stroke. The upper or "actuating" cylinder is connected by means of a cross-head with two side links, to one end of a rocking lever working upon a fixed fulcrum, whilst the other end of this rocking lever is connected to a crank by a connecting-rod.

Thus, when the crank is put in motion, the rocking lever raises the side links, and with them the upper cylinder, until the top piston cuts off the air at the bottom row of holes in same, and, this air becoming compressed by the cylinder still continuing to rise, eventually lifts the top piston with it, and thereby the piston-rod and tup. Upon the crank passing the bottom of its stroke, the top cylinder gains upon the falling piston and tup until it closes the communication of the air through the top row of holes, after which this air is compressed, and the motion of the falling piston and tup is thereby accelerated. If now the lower cylinder is in free communication with the atmosphere through its bottom air ports, the tup will fall to its lowest point, viz., the face of the anvil, and the full force of the blow will be struck; but if all these air ports are

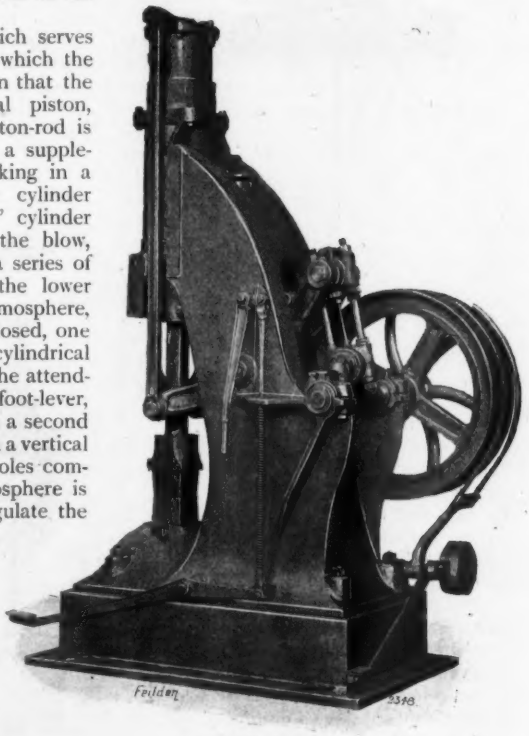


FIG. 8.—SAMUELSON AND LONGWORTH'S 3-CWT. SINGLE STANDARD HAMMER FOR GENERAL FORGING.

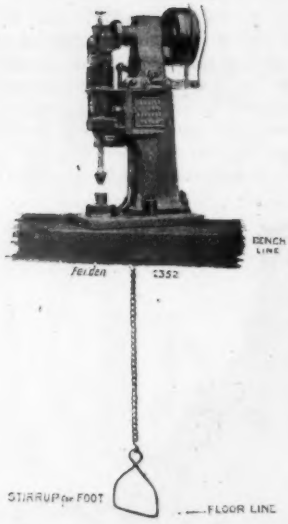


FIG. 9.—QUICK-SPEED RIVETING HAMMER.

closed, the lower piston will compress the air in the bottom of the controlling cylinder, until that pressure is sufficient to sustain the falling weight, and the tup will be prevented from striking the anvil.

Small self-acting air valves in the bottom cylinder allow air to be drawn in by the lower piston on its upward stroke when necessary to restore atmospheric equilibrium; these, however, remain at rest when the lower cylinder has free atmospheric communication through the lower ports. The top of the lower cylinder remains in free communication with the atmosphere at all times. The cylindrical air valve is under the control of the attendant by means of a suitable system of hand or foot-levers, and is kept in its normal position covering the whole of the air ports to the lower cylinder by means of a spring, as shown on Fig. 7, etc., and when the hammer is started, the piston works upon an air-cushion, as explained, and the work can be readily introduced upon the anvil. By opening one or more of these air-ports the air-cushion in the lower cylinder is regulated and the force of the blow controlled, and by rapidly opening and closing them again, the attendant can deliver single blows upon his work—this of course being contingent upon the thickness of height of the iron being less than the clearance between the tup and anvil when the hammer is running upon its greatest air-cushion, which can be allowed for in the designing of the hammer to suit particular work. The speed and stroke of the hammer can be made suitable for different classes of work. Thus for riveting or cutler's work a quick speed and short stroke can be maintained, as many as 400 to 500 blows per minute

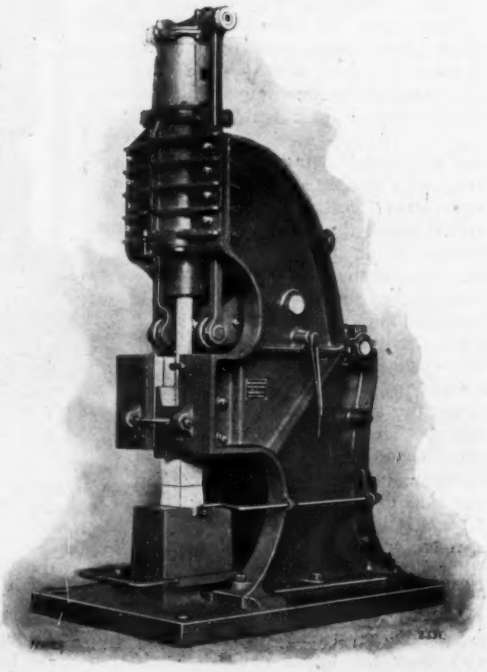


FIG. 10.—8-CWT. DOUBLE FRAME FORGING HAMMER.

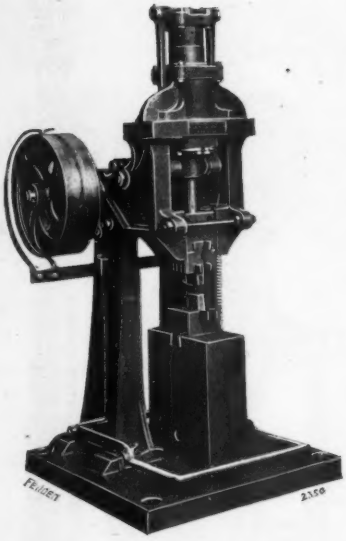


FIG. 11.—1-CWT. QUICK-SPEED HAMMER FOR CUTLER'S WORK.

being delivered, whilst for general forging or stamping, the hammer can be made with a long stroke, and a moderate speed of 120 to 180 blows, which is necessary to enable the attendant to move or handle his heat upon the anvil.

Fig. 9 illustrates one of the former type for riveting work, whilst Figs. 8 and 10 illustrate a type for general forging purposes.

In riveting small work, a better finish is obtained when forming a "snap" head by making the top tool to revolve, thus giving a sort of spinning action on the head of the rivet. These little hammers are useful adjuncts in such work as chain riveting for cycles or kindred purposes, and show in actual work an increase in production of over 4 to 1 in the amount which can be turned out by simple hand riveting in the former purpose.

Owing to the comparative length of the side links, the versed sine of the arc through which the end of the rocking lever moves affects but slightly the true vertical motion of the top cylinder, and the tendency to wear sideways is reduced practically to a negligible quantity by being guided in a long neck or gland on the top portion of the piston-rod in the earlier design. The lower or main piston rod is similarly guided in another long neck on the lower cylinder, and the tup is placed between side guides where a hammer of this type is required, as in Fig. 10. In order to reduce the total height and to better guide the top cylinder, the author has more recently brought this cylinder down to work inside the controlling cylinder, Fig. 7, making the top cover serve as a guide, thus relieving the piston-rod of that function, the links being journalled on pins formed on the top cylinder cover, see Figs. 8 and 10, etc.

In the earlier design the wear of the tools was provided for by the cross-head being adjustable upon the top cylinder gland (see Fig. 6), whilst in the later

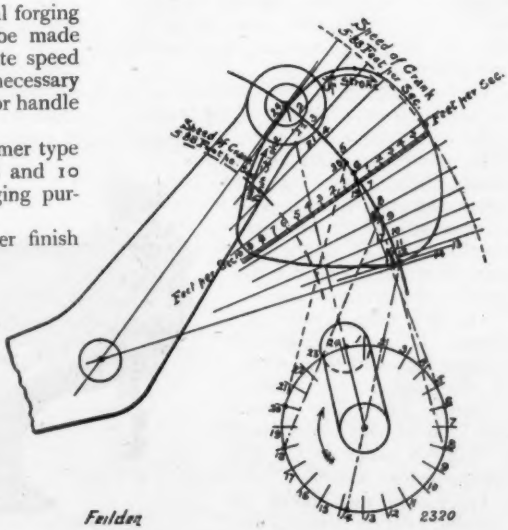


FIG. 12.—ILLUSTRATING ACCELERATION OF ACTUATING CYLINDER, DUE TO POSITION OF CRANK AND ROCKING LEVER OF ABOVE HAMMER.

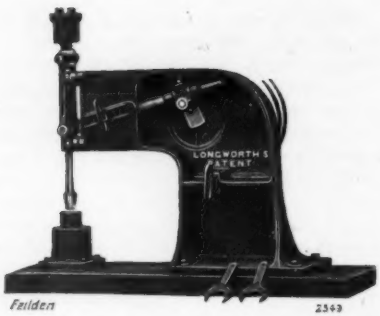


FIG. 13.—"LONGWORTH" BENCH HAMMER FOR PLANISHING.

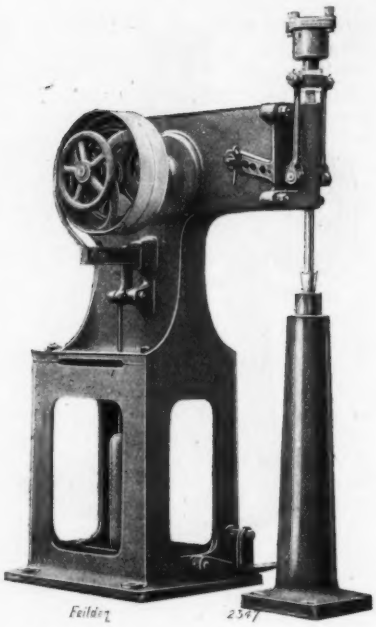


FIG. 14.—"LONGWORTH" PLANISHING HAMMER ON STOOL.

design the connecting-rod to the crank is made so that it can readily be lengthened or shortened, as shown in Fig. 7, the proper position of the top cylinder relative to the anvil being, when the faces of the tool are touching each other, and the front end of the rocking lever is at the lowest point of its stroke, the bottom of the piston in the top air cylinder should just cut off or close the bottom row of holes in same. The working cylinder being so far removed from the work upon the anvil, no danger is incurred from grit or heat affecting it.

Fig. 12 illustrates the acceleration of the actuating cylinder due to the position of the crank and rocking lever. Reciprocating motion is given to the hammer head in this class of power hammers by means of a crank and slide blocks before mentioned, or by means of a short connecting-rod from the crank to the cylinder cover.

The first form is only employed in the Longworth hammer for small sizes, whilst in the larger or heavier hammers the author prefers the form of drive illustrated in Figs. 8 and 10 for the reasons before stated.

For planishing work a movable fulcrum hammer was designed about 1878 by Mr. Longworth, which enabled the blows to be varied in intensity, due to the difference in the length of the stroke, the shock on the tup being taken up by means of a small air cylinder above the hammer

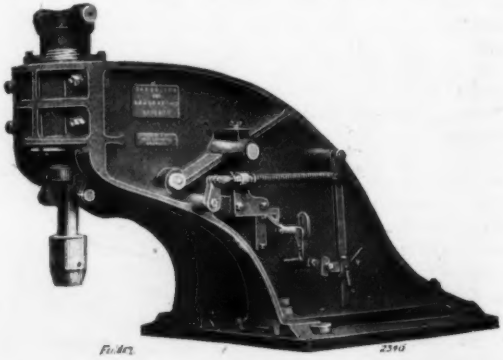


FIG. 15.—BOILER FLUE WELDING HAMMER.

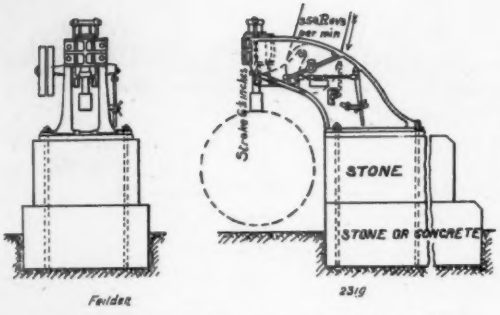


FIG. 15A.—LONGWORTH POWER HAMMER: 1-CWT. HAMMER FOR TUBE WELDING.

head, but a simpler form was subsequently designed by him in which the fulcrum was made adjustable as shown in Figs. 13 and 14, where the piston rod and tup are actuated through side links from the rocking lever, with an air cylinder above the hammer, and well away from all danger of grit and dirt. The fulcrum in this case is moveable only when the hammer is at rest, this being found sufficient for all practical purposes, as when the strength of the blow is once determined, it seldom requires to be altered in the course of the manipulation of the work under it, and can be easily effected when desired, thus dispensing with a certain number of movable parts, which naturally in a quick speed hammer is a great advantage.

The variety of work which these hammers are called upon to perform is multitudinous, and Figs. 15 and 15A show a hammer specially designed for boiler flue or tube welding. The flues or tubes can be manipulated upon any ordinary anvil, such as are commonly used in boiler shops, adjusted to the proper height, and a very great advantage is obtained in the use of such a hammer in this class of work, because of the uniformity or regularity in the number of blows given per minute, which it is difficult to obtain in steam or power hammers of the first class described in the earlier portion of this paper.

In welding a flue the first blows are required to be of a heavy nature to form the weld, whilst the subsequent blows should be of considerably less intensity to finish off the work, but whilst the intensity of the blows in the later portion of the

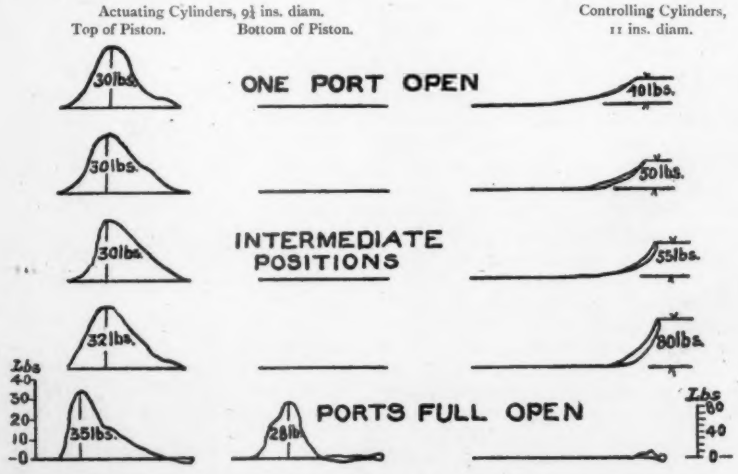


FIG. 16.—DIAGRAMS OF 3-CWT. HAMMERS: 132 BLOWS PER MINUTE, 368 LBS. FALLING WEIGHT.

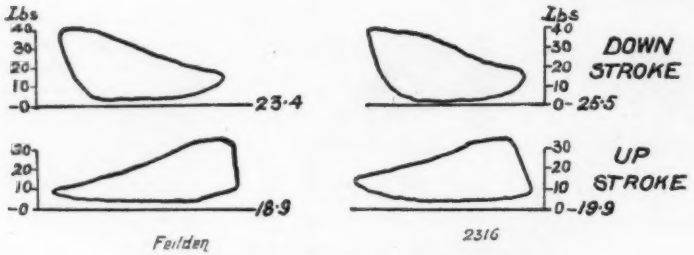


FIG. 17.—DIAGRAMS OF 4-CWT. STEAM HAMMERS (420 LBS.).
Cylinder, 8 ins. diam. ; 16 ins. stroke ; 120 blows per min. 10 i.h.p.

process should be decreased, the speed or number of blows should be maintained ; if possible an advantage would accrue if they could be increased, in order to take the fullest possible advantage of the heat. In a steam hammer, as well as in belt driven hammers of the first type, when this finishing part of the process is being performed, the speed or number of blows becomes reduced, but in the Longworth Hammer the speed is uniform, and thus a longer weld can be made in one heat.

The power required to drive the Longworth hammer is proportionate to the work being obtained from same, for when the hammer is running upon its full cushion of air in the controlling cylinder, the compressed air assists in raising the tup on its upward stroke, and a minimum power is required. This increases as the blow is intensified until no cushion exists, and the full blow is given. For instance, taking a 3-cwt. single standard hammer, the power absorbed when running light at 135 blows per minute under electric motor, is 5 amp., say, 1·47 h.p. as found in actual practice ; whilst when running on its full blow at 135 per minute the power absorbed is 15 amp. = 4·41 h.p., the voltage being 220.

Fig. 16 shows cards taken from the top and bottom of the actuating cylinder of the same 3-cwt. hammer, and from the controlling cylinder when one air port is open down to the position where all are open, and the hammer is giving its fullest blow. Fig. 17 represents cards taken from a 4-cwt. steam hammer, having 8-in. cylinder with 16-in. stroke, which shows the wasteful power expended in tools of this class, for whilst about 64 lbs. of water are required per i.h.p. per hour to work this hammer from the calculations as below, a fairly economical engine should not use more than about, say, 20 lbs., and it is in this respect that the advantage of a power over a steam hammer is most evident.

Water consumption of 4-cwt. steam hammer, as taken from cards on Fig. 16, the average pressure at end of stroke being 15 lbs. above atmosphere :—

Cylinder, 8-in. diameter by 16-in. stroke ; number of blows per minute, 120. Thus $50 \times 16 \times 120 \times 2 = 192{,}000$ cub. ins., or the volume of steam used per minute. Specific volume of steam at 30 lbs. absolute = 838. Thus $\frac{192{,}000}{838} = 229$, or the cubic inches of water used per minute, and $229 \times 0{\cdot}036 \times 60 = 494$, or the lbs. of water per hour. The i.h.p. being 10, as taken from the cards, the water used per i.h.p. per hour = 49·4, to which must be added a liberal allowance for condensation in the cylinder and steam pipes, say 30 per cent., which would make the consumption of water = 64 lbs. per i.h.p. per hour.

Power hammers have not been successfully designed of larger capacity than about 10 cwts., but for weights under this the great advantages of such tools merit the careful consideration of users.

Ernest Samuelson.

Gold-Mining Machinery.

By PHILIP R. BJÖRLING.

(Continued from page 559, Vol. III.)

MORTARS FOR GOLD MILLS.

THE mortars vary in design to suit circumstances. Fig. 29 illustrates Messrs. Edward Chester & Co.'s, Ltd., Standard Mortar. This mortar has a single discharge. It is fitted with cast-steel liners, which can be easily drawn out and replaced by fresh ones as necessity requires, and it is also fitted with a false bottom in halves, to allow of its being easily removed. A wearing-plate is fitted on the feed-lip, which can also be detached when a new one is required. Two long keys are supplied for each side of the mortar for holding in the screen and chuck-block. Three sets of chuck-blocks, 3 ins., 5 ins., and 7 ins., covered with copper-plate, are supplied, and one back-plate with washers and bolts for fixing on the back of mortar.

The ore is introduced through the opening in the back near the top, and is distributed under the stamps by their own action peculiar to the order of their drop. Water enters at the top against each stamp and carries the crushed pulp through the screen as fast as it becomes fine enough, being dashed against the screens by the falling stamps. Amalgamation takes place inside of mortar on copper plates by pulp being dashed against them.

Messrs. Fraser & Chalmers' mortar for

Dry Crushing Mills

is depicted in Fig. 30. All mortars for dry crushing are made with double discharge, the dies being so placed that the dry pulp will easily reach the screens when it is dashed up against them by the action of the stamps. One great difficulty in securing the full capacity of stamps of heavy weight is to remove the pulp as fast as it accumulates, and this point is gained as nearly as possible in the construction of this mortar. For ease of transport in mountainous countries

Sectional Mortars

are frequently used. One of these mortars with single discharge is illustrated in

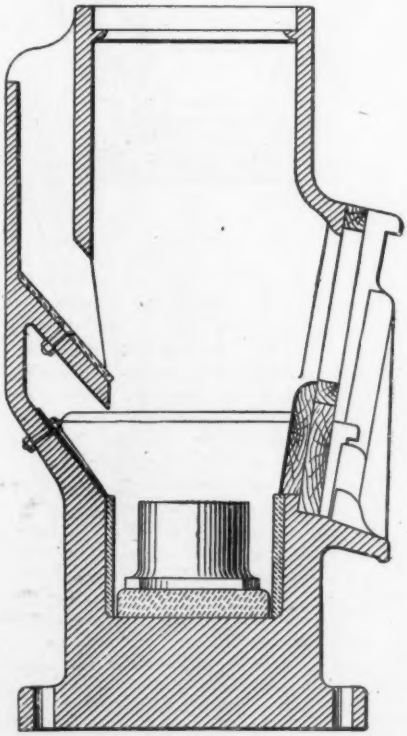


FIG. 29. STANDARD MORTAR BY EDWARD CHESTER AND CO., LTD.

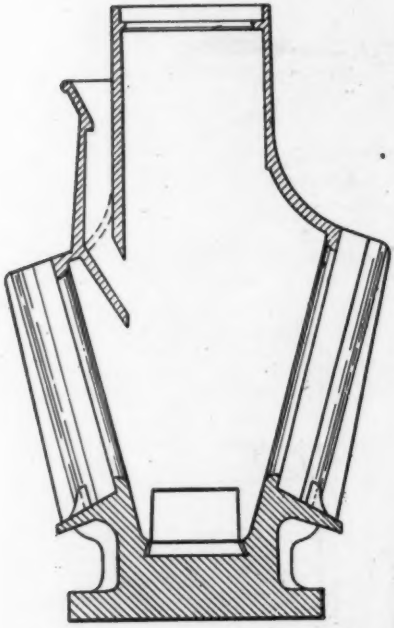


FIG. 30.—MORTAR FOR DRY CRUSHING MILLS.

sectional elevation Fig. 31 and cross-section Fig. 32. The base is made of case-iron, in sections planed and fitted to each other and bound together longitudinally by perfectly fitted bolts. The housing is made of boiler-plates, to reduce the weight and avoid possible breakages, and the joint is made in a peculiar manner, which ensures accurate fit.

A sectional mortar with double discharge is illustrated in transverse section Fig. 33. It is constructed very much on the same principle as the single-discharge mortar. It is lined with chilled iron or steel plates, and copper plates can be fixed under the feed opening and the discharge, as preferred by some mill-men. The screens are secured on to wooded frames in the usual manner.

STEAM STAMPS.

The steam stamp illustrated in Fig. 34 was manufactured by Messrs. Fraser & Chalmers for Anaconda, Broken Hill, Proprietary, and other great mining companies. It is a very large and powerful machine, suitable for use in connection with the large mines and ore dressing works, and capable of pulverising an enormous quantity of ore. One of these large stamps will reduce as much ore as an ordinary mill of 60 to 100 stamps or more.

The stamp is driven by a vertical steam cylinder with valve-gear designed to keep the top steam port fully open during the down-stroke, adding the power of the steam to the weight of the stamp, while for the work of the up-stroke (merely lifting the stamp) a small steam admission suffices.

The mortar has four discharge screens, and rests on a heavy anvil or bed-plate. Angle guide-pieces, cast upon a massive and rigid framing of iron columns, hold the mortar in place. The upper and lower guides for the stamp stem are removable bronze bushes, in which the stem is slowly revolved by means of a horizontal pulley on a sleeve between upper and lower brackets. This sleeve is brass bushed, and contains two feathers fitting in corresponding slots in the stamp stem by which the latter is rotated. The piston rod is of steel and is connected to the stamp stem by a circular disc, which is enclosed by a cast-iron bonnet bolted to the flange of the stem. The space between is filled with pure gum-rubber

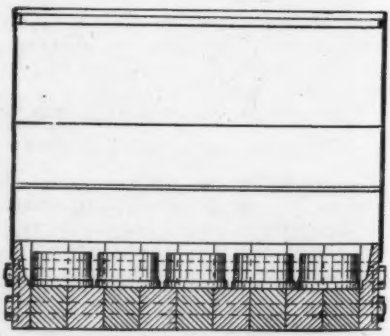


FIG. 31.—SECTIONAL MORTAR.

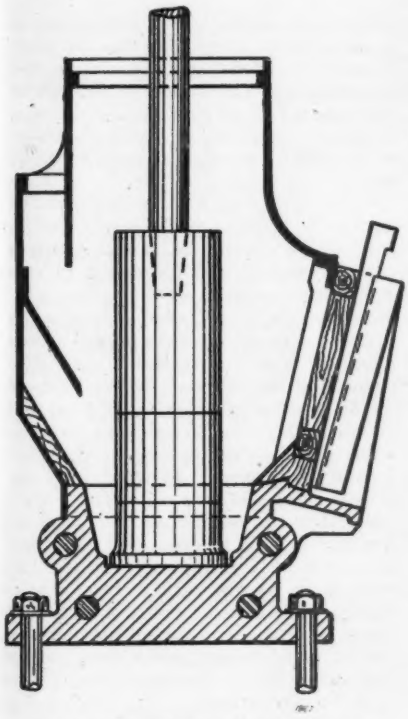


FIG. 32.—CROSS SECTION OF SECTIONAL MORTAR.

packing. This arrangement relieves the shock on the piston and permits its removal for repairs without disturbing the stamp. The piston is made of steel and fitted with bronze packing rings.

In cases where material is required to be crushed, and not reduced to too fine size, this stamp is very suitable.

Fig. 35 is an illustration of a steam stamp manufactured by Messrs. Edward Chester & Co., Ltd.

The stamp itself weighs about 25 cwts., and gives a blow equal to 5 tons. The foundation, which formerly used to be made of wood, is now put in of iron, set in concrete.

The valves are of the Corliss type, actuated by elliptical spur-gear, the fly-wheel being attached to the shaft operating the gear, which ensures a regular and even action.

To a mesh of 20 holes per inch this stamp will crush about 300 tons per day, and its capacity is greatly increased owing to the box being so constructed that there is a discharge all the way round. The inside of the box is protected with very heavy iron grids, so that the violent action of the stamp does not cut out the screens. The stamp is made to revolve by an independent gear that is fixed on the stem.

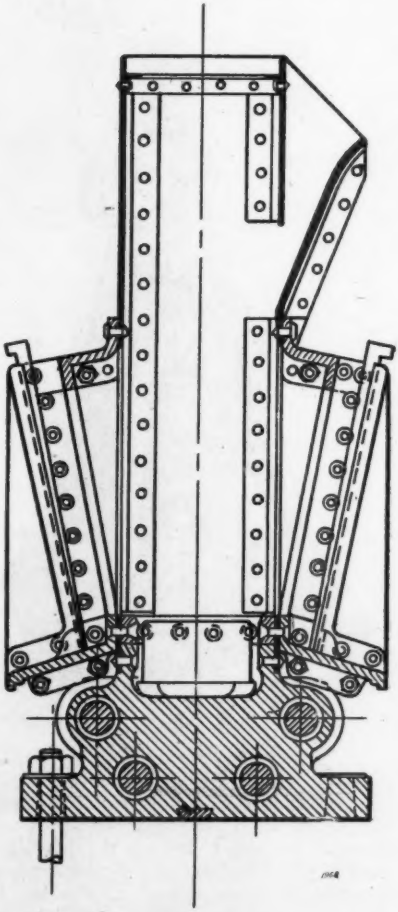


FIG. 33.—SECTIONAL MORTAR WITH DOUBLE DISCHARGE.

These steam stamps weigh about 80 tons.

"TREMAIN" STEAM STAMP.

This steam stamp mill, illustrated in Fig. 36, is a reproduction from a photograph. Like the other steam stamps, it is perfectly self-contained, and consists of two stamp stems, the upper ends of which terminate in pistons, working in cast-iron cylinders, after the manner of a

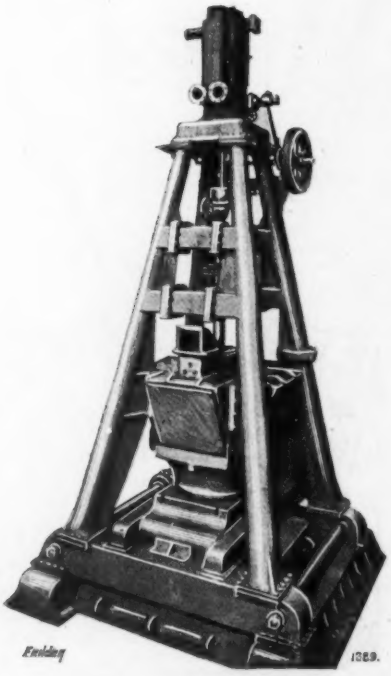


FIG. 34.—STEAM STAMP.
BY MESSRS. FRASER AND CHALMERS, LTD.

steam engine. These pistons are turned out of the solid forging which forms the stamp stem; they are 5½ ins. diameter, and fitted with three sets of piston rings. making them steam-tight. The piston rods which pass through the stuffing boxes are 4 ins. diameter, therefore the steam pressure, which is admitted under the piston to raise the stamp, is confined to an area which is equal to the difference between the diameter of the piston and the piston rod, amounting to an annular ring about ¾ of an inch wide, which area is small but sufficient to enable the stamp to be quickly raised, the total weight of which is but 300 lbs.

Either piston in its travel towards the top of the cylinder passes a small steam port, which admits the pressure to the valve mechanism and moves the valve to its opposite position, which movement of the valve cuts off the admission of steam to the under-side of one piston and admits it to the other piston, at the same time connecting the top and bottom ends of the first-mentioned cylinder together, thus allowing the confined steam, which is holding the stamp up, to be expanded around the piston to its upper side, and acting expansively upon the area there encountered to so energetically assist the 300-lbs. stamp in its downward movement as to strike a blow upon the die equal to that of an 800-lbs. to 1,000-lbs. gravity stamp. The pistons alternate with each other perfectly, and when the valve is moved back to again admit steam to the under-side of the first-mentioned piston it also connects the top-side with the exhaust port, so that the steam remaining after the blow has been struck is passed into the atmosphere. This arrangement makes it possible to use the steam expansively, and to obtain the same crushing effect with each drop of a 300-lbs. stamp as would be obtained with a gravity stamp of 800 to 1,000 lbs. dropping 8 ins. (depending upon the pressure used). Instead of being limited to about 90 drops per minute, as with the gravity stamp, this stamp is able to go at a speed of 200 or more drops per minute of each stamp, and it will be obvious that the crushing capacity must be correspondingly increased. The capacity of this mill varies, of course, with the character of the ore and size of mesh of the screens in use—from 8 tons to 25 tons of the friable material. Experience has shown that it can safely be calculated that the Tremain Mill will pulverise from 10 to 15 tons of ordinary gold quartz through a 40-mesh screen in 24 hours.

The power required to operate the mill varies materially with the speed at which it is run—from 7 to 10 h.p.

The water required to operate the mill and boiler is $1\frac{1}{2}$ miner's in., equal to about 800[5] gals. per hour, although 1,000 gals. per hour if sufficient water can be had.

This mill has a large screening capacity, there being about 450 sq. ins. of screens used in the mortar, as against 475 sq. ins. in the standard 5-stamp gravity mortar. The mill is an excellent amalgamator both n the mortar and upon the apron-plates. Inside copper plates are used as well as lip-plates on the mortar, and experience proves that about 8 per cent. of the amalgam is collected from the inside of and upon the lip-plates attached to the mortar.

These mills are admirably adapted for prospecting, although, as will be seen by referring to Fig. 37, they are used in some instances for permanent works. In this case they are arranged in a battery of eight, equal to 40 head of gravity stamps. The question as to the eight stamps being as economical in driving power as the 40-head stamps is a very open one.

ORE MILLS.

A great number of ore mills have been invented to supersede the stamp mills, although for wet crushing the gravity stamps hold their own. Some of the advocates for the mills argue that the stamps flour the mercury, but if it does it is so little that it still pays to use them in most places, but for dry crushing the

Huntington Mill

is very good and does its work admirably. The ore and water, if wet crushing is

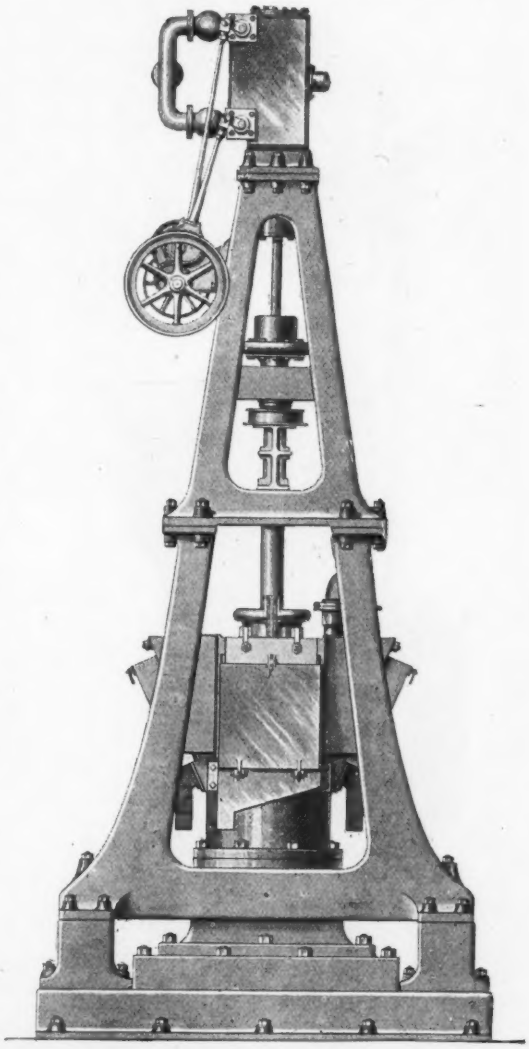


FIG. 35.—STEAM STAMP, BY EDWARD CHESTER AND CO., LTD.

required, is fed into the mill at the hopper; the rotating rollers and scrapers throw the ore against a ring die, where it is crushed to any desired fineness by the centrifugal force of the rollers as they roll over it.

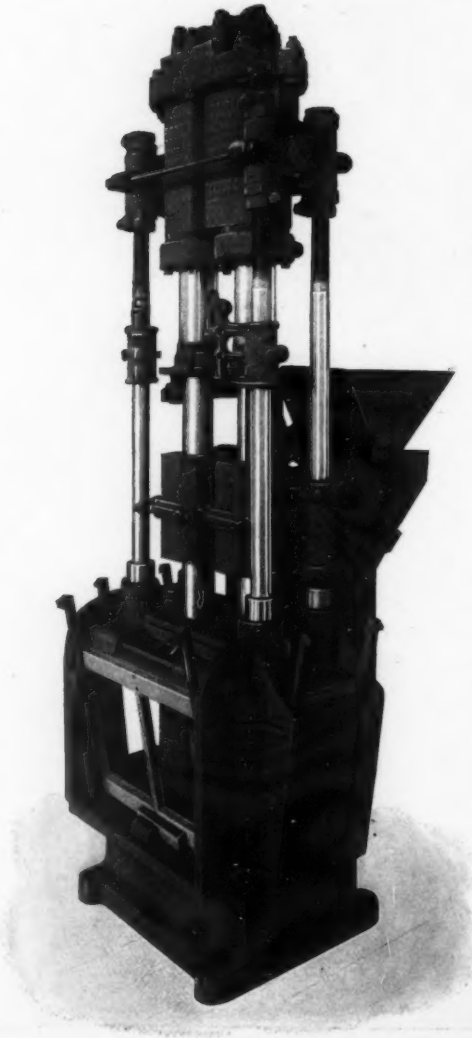


FIG. 36.—THE "TREMAIN" STEAM STAMP.

The water and pulverised ore are thrown against and through the screens when fine enough. The discharge is so perfect that it makes little or no slimes, and leaves the pulp in good condition for concentration. The rollers are suspended, leaving a space of 1 in. between them and the bottom of the mill, thus allowing them to pass freely over the quicksilver and amalgam without grinding it or throwing it from the mill, while it agitates it sufficiently to make amalgamation perfect.

These machines are especially adapted for crushing ore direct for fine concentration, for crushing the tailings for jigs in coarse concentrating mills, for subsequent treatment on Frue Vanners or other slime concentrating machinery. For the latter purpose the machines are in use in the Bulle and Boston Mill, Montana, where they receive the coarse tailings from the jigs, which are equivalent to an average size of $\frac{1}{4}$ in., and crush the same to 20-mesh and below. For this purpose each machine has a capacity of 75 tons of tailings per day crushed to 20-mesh.

For fine concentration purposes this mill pulverises ore and leaves it in a better condition for amalgamation than any other machine, for the reason that it crushes wet and the screen surface is large, allowing the ore to be discharged as soon as it is fine enough to pass through the screens.

Fig. 38 is a sectional elevation of Messrs. Fraser & Chalmers' Improved Huntington Mill, Fig. 39 a sectional elevation of one of these mills 6 ft. in diameter, four of which were manufactured for the Colorado Smelting and Mining Company.

The plates for the Huntington Mill should not be placed, as is usual for stamp batteries, in one continuous piece 8 ft.

FIG. 37.—BATTERY OF STEAM STAMPS.

long, but the current should be changed by drops, a good arrangement being to use three plates each 4 ft. by 4 ft., making a total length of 12 ft. in plates with successive drops of 4 ins. and a separate amalgam drop and distributor after each 4-ft. by 4-ft. plate. To make this table, take two 1½-in. planks 12 ins. wide and lay out the sides by cutting them to a length of 13 ft. 3 ins. Rip down each with a saw 4 ft. 5 ins. from head, make a drop of 4 ins., again rip down 4 ft. 5 ins., drop 4 ins., and rip saw to the end. This makes the sides each of one piece. Then fit the upper ends under the mill, to make the distributors of 1 in. boards 4 ins. wide, to fit inside the table with holes, the centres of which are 2 ins. from the bottom and 2 ins. apart and $\frac{5}{8}$ths of an inch diameter, except the four nearest the centre, which are usually made $\frac{3}{4}$ of an inch diameter. The bottom of the table is jointed to put on with screws, and the distributing partitions (with pieces of blanket under them to make good joint) are screwed in tight from the bottom. No screws are put through the plates, but they are held in places by means of cleats, with pieces of blanket or rubber gasket under the screws, to the sides of the table.

In setting the table it must be adjusted according to the ore to be treated. On some ores 1¼ ins. to the foot is sufficient; other ores require as much as 1¾ ins., and 1½ ins. (intermediate between the two) is usual.

At the end of the plate is an amalgam trap and launder, carrying the pulp to the side of the table. This trap is a box 12 ins. wide, 12 ins. deep, and as long as the width of the table. It has three partitions, making four sections, into the first of which the ore drops through a 2-in. pipe running to within 4 ins. of the bottom.

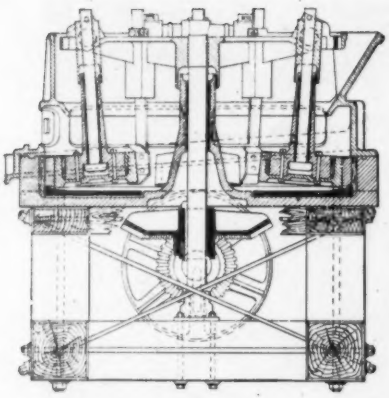


FIG. 38.—SECTIONAL ELEVATION OF MESSRS. FRASER AND CHALMERS' "HUNTINGTON" MILL.

The first partition extends from the bottom of pipe. The second partition extends from the top of box down to 1 in. below top of first partition. The third partition extends from the bottom of the box to 1 in. above the bottom of the second partition. From the last section the pulp is discharged through a launder.

If the ore carries sulphurets, the pulp should then be run over concentrators.

A very good mill, which has been and is still largely used in Western Australia, is the

GRIFFIN MILL,

manufactured by the Bradley Pulveriser Company, Boston, Mass. This mill exists in two types, namely, the dry mill and the wet mill.

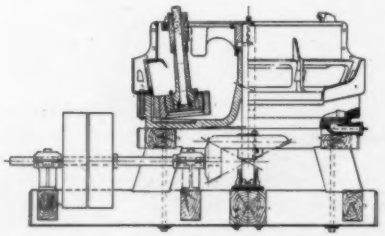


FIG. 39.—SECTIONAL ELEVATION OF 6-FT. "HUNTINGTON" MILL.

The wet mill is shown in part sectional elevation in Fig. 40. By this mill an uniform product is produced, every particle of which is perfectly fractured. The material is reduced entirely by the crushing force of a roller. It will be seen that the power is received by a horizontal pulley. From this pulley is suspended a shaft or spindle by means of a universal joint, and to the lower extremity of the spindle is rigidly secured the crushing roll, which is thus free to swing in any direction within the case. The case consists of the base or pan, containing a ring or die, against which the roll works, and upon the inner vertical surface of which the pulverising is done.

In dry pulverising, this pan or base has a number of openings through it downward, outside of the ring or die, which lead into a pit or receptacle below. Upon this base is secured the screen-frame, which is surrounded with a sheet-iron cover, and to the top of which is fastened a conical shield, open at the apex, through which the shaft works. Above the pulverising roll attached to the lower end of the spindle is secured a fan, which is only used in the dry crushing mill. On the under-side of the roller are secured shoes or ploughs, which are used both for wet and dry pulverising. The shape of these ploughs is varied according to the nature of the work to be done.

The pulley revolves upon a taper bearing, which is supported by the frame, composed of three standards. Two of these standards are extended above the pulley to carry an arm, in which is secured a hollow journal pin. Within the pulley is the universal joint from which the shaft is suspended. This joint is composed of a ball or sphere, with trunnions attached thereto. These trunnions work in half-boxes, which slide up and down recesses in the pulley-head casting. The joint in the pulley is enclosed by means of a cover, thus keeping the working parts from all dust and grit.

The roll is revolved within the die in the same direction that the shaft is driven, but when coming in contact with the die it travels around the die in the opposite direction from that in which the roll is

revolving with the shaft, thus giving the mill two direct actions on the material to be pulverised. There is a pressure by centrifugal force of 6,000 lbs. brought to bear on the material being pulverised between the roll and die, the united action being very effective in their combination.

In working dry, the screen which surrounds the pulverising chamber is of much coarser mesh than the delivered product; for instance, a 16-mesh screen delivers a product 90 per cent. of which will pass a 60-mesh screen.

In wet pulverising the water is introduced with the feed, and when the mill is running the roll imparts to the water and material in the mill a whirling or rotary motion, which carries the pulp up and against the screens, making the entire surface thereof available, and also gives a quick delivery.

The fine material, with the water composing the pulp, passes through the screens into the surrounding trough, and is discharged on one side, whence it may be passed over plates or into an amalgamator or concentrator, as desired.

THE BRYAN ROLLER MILL,

manufactured by the Risdon Iron & Locomotive Works, San Francisco, Cal., is illustrated in Fig. 41. It is in reality a modification of the old and well-known Chile Mill, arranged for continuous wet crushing of gold ores. This mill consists of an annular mortar containing fixed segmental steel dies, arranged in the path of its three crushing rollers, which in a 5-ft. mill are 43 ins. diameter, 7-in. face, and weigh 3,650 lbs. each, whose axles are fixed in them, and journalled in a central revolving table, attached to and driven by the overhead gear, making a very direct application of power. The crushing weight of the roller can be increased as desired by loading a tank. A large screening area is obtained in this mill, hence permitting the free discharge of all pulverised ore, thus preventing the possibility of sliming.

They are good amalgamators, and save a large percentage of gold. Some millmen prefer these mills to stamps for the reason that they are portable, quickly and cheaply erected, require less power, and a less first cost than stamp mills.

The 5-ft. mill makes 30 revolutions per minute, deals with 25 to 35 tons per day, and require 6 h.p. to drive it; and the 4-ft. mill makes 60 revolutions, deals with 12 to 20 tons per day, and requires 5 h.p.

BALL MILLS.

There are a great number of these mills on the market, too numerous to be introduced into these articles, therefore we must confine ourselves to two examples, namely, the "Humboldt" and the "Western" Ball Mills.

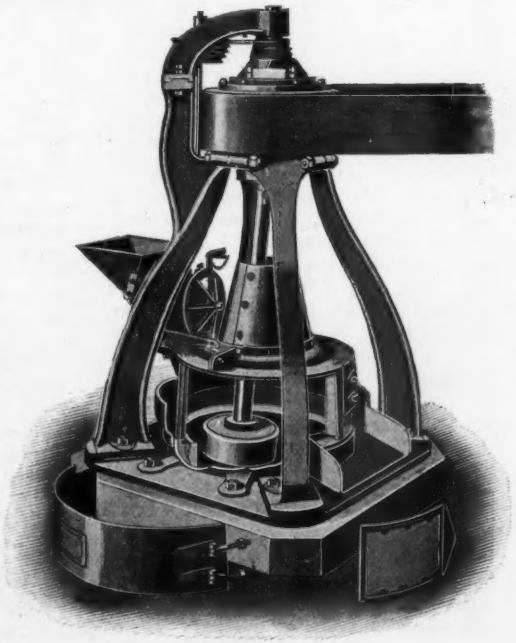


FIG. 40.—THE "GRIFFIN" MILL.

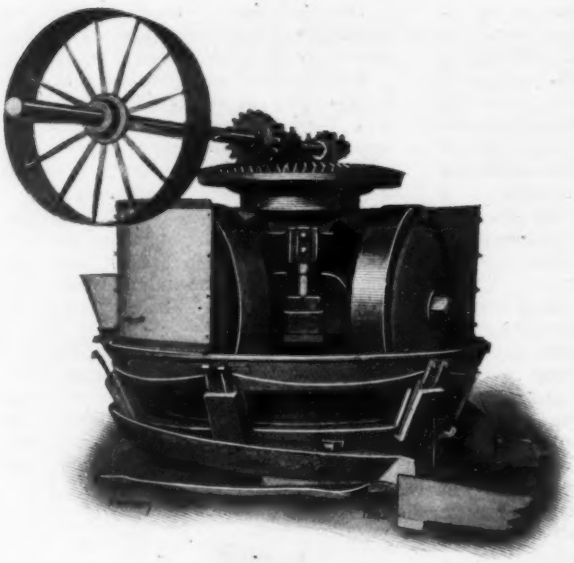


FIG. 41.—THE "BRYAN" ROLLER MILL.

The ground product falls through the perforations of the drum, first, on to the projecting screen, which retains the coarser grains, and the fine product falls on to the outer fine screen. The material remaining on both screens is conveyed to the side channels *L* by means of spiral blades fixed in two places to the inner sides of the screens, and then re enters the drum to be further reduced.

The material which passes the outer screen, or the finished product, collects in the hopper *M*, from which it can be let off into vessels or sacks placed underneath through an opening provided with a door. The whole mill is enclosed in a sheet-iron casing for protection against dissemination of dust. The mill is driven by means of spur-gearing and fast and loose pulleys; in the small sizes the gearing is omitted and the fast and loose pulleys are on the drum-shaft.

As we believe the

"HUMBOLDT" BALL MILL

to be the older of the two, we will commence with that. The construction of this ball mill will be readily understood by referring to the sectional elevation Fig. 42, the transverse section Fig. 43, and a general view Fig. 44. The drum or barrel *A* consists of a shell of perforated cast-steel plates *B* and of wrought-iron ends, *C* protected on the inside by cast-iron plates and carried by the cast-iron bosses *F*, which are keyed on to the wrought-iron shaft *G* carried in two pedestals. Outside the grinding-drum *A* are fixed two concentric screens *H* and *J*, of which the inner screen *H* has coarse perforations, and serves to protect the outer screen *J* with fine perforations.

Inside the grinding-drum are a number of steel balls, which crush and grind the material to be reduced, which is fed into the drum by means of a hopper *K*, and suitable openings in one of the drum-end bosses during the rotation of the drum.

One great defect is often found in ball mills, that is the material which has not passed the screens, and which is intended to be returned to the grinding-drum through openings in the shell, blocks up these openings, and coarse material collects between the screens, and the screening then ceases altogether. If, to remedy this, the screens are made conical and the coarse material is returned to the drum through openings in the end of same, only a part of the material passes over the screens, so that the latter are not fully utilised.

WESTERN'S PATENT BALL MILL.

This ball mill is clearly shown in transverse section at Fig. 45. This machine consists of a revolving cylinder, into which

the ore is automatically fed through the hollow axis. The sides of the cylinder are armour-plated, and the periphery is of a peculiar form, composed of hard steel curved plates with perforations, and is surrounded by a series of screens. The grinding is done by the very hard steel balls of various sizes inside the cylinder rolling and falling on the ore.

The arrangements are such that the ore once introduced inside the cylinder cannot escape until it is reduced to the desired size—gauged by the fineness of the outer screen.

To get the best value from the machine the ore should, of course, be first reduced by an ore crusher or roller, leaving the balls to do the fine work.

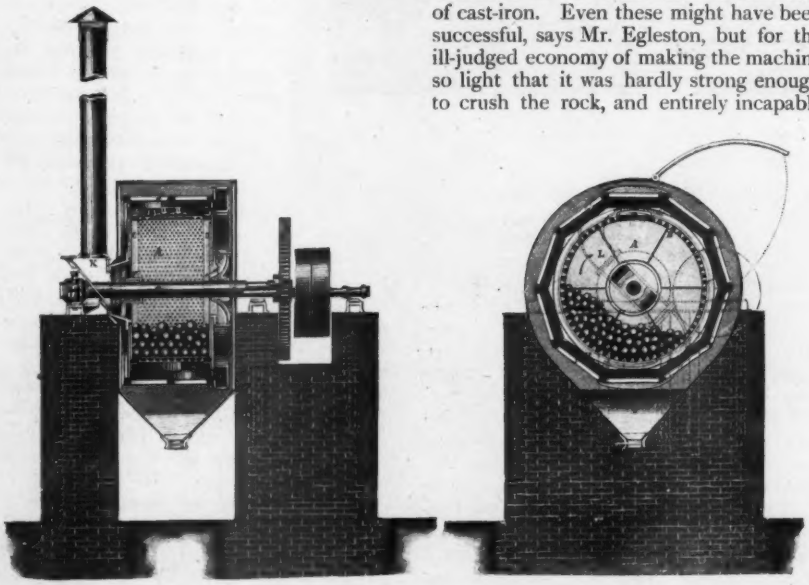
This mill is of special utility where the object in view is to obtain a large percentage of very fine-ground material. In fact, most substances can be reduced to an impalpable fineness, the only limit in this respect being the screen itself.

The special feature of this mill is the improved feeding apparatus, whereby the material to be ground is evenly distributed throughout the interior instead of merely being thrown in at one side as in the ordinary make.

These mills may be used for either dry or wet crushing. The former is most commonly employed, and in this case an exhaust fan or other means of collecting the dust should be provided.

Crushing Rollers.

For a long time it was supposed that the California Stamp was the perfection of machinery for crushing, and that nothing could take its place. It was admitted that rolls were adapted for crushing ore to such a granular state as is most suitable for concentration, but even in concentration works the stamp was largely used up to about the year 1882. Mr. Egleston informs us that the prejudice against rolls arose in America mostly from very ill-advised experiments undertaken in the early days of Lake Superior, when the effort was made to reduce hard rock containing large nodules of native copper to a condition fit for concentration with rolls of cast-iron. Even these might have been successful, says Mr. Egleston, but for the ill-judged economy of making the machine so light that it was hardly strong enough to crush the rock, and entirely incapable



FIGS. 42 AND 43.—THE "HUMBOLDT" BALL MILL.

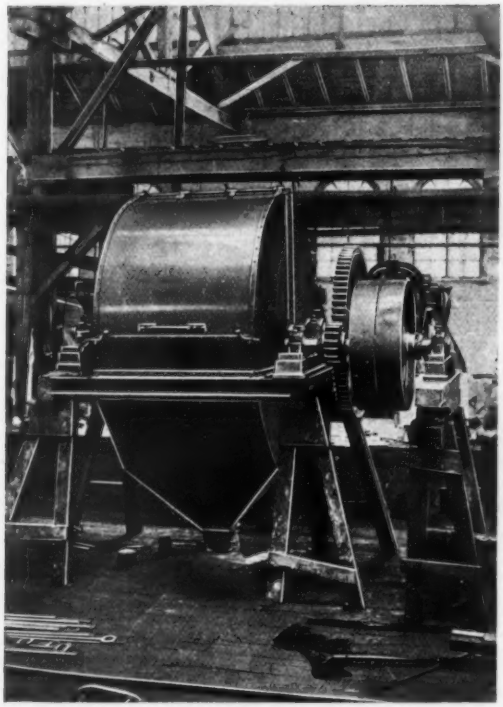


FIG. 44.—GENERAL VIEW OF THE "HUMBOLDT" BALL MILL.

of rolling out native copper, so that the copper lumps could not pass the rolls, which were consequently often jammed between them, so that they had to be taken apart, if the force was not sufficient to roll them out, or to break the rolls.

At first it looked like a return to obsolete methods, for the modern stamp battery to again adopt rolls; but it was soon found that not only was the cost of the plant much cheaper, but also that the efficiency, so far at least as leaching works were concerned, was far greater, for the pulp which came from rolls was found to contain much less fine dust, and the particles to be much more uniform in size than those which came from the stamps.

It is almost impossible to make any comparison between the efficiency of stamps and rolls, except in special cases where both methods have been tried for crushing the same ore at one and the same place.

It is a well-known fact that for wet crushing the stamp battery is far superior to the rolls, although some advocates for rolls propose that the ore should be crushed dry and then wetted down.

Dry crushing by stamps costs about one-third more than wet crushing, as the capacity falls off to that extent, although double discharge mortars are used, and sometimes assisted by a current of air produced by means of a blower.

The typical form of crushing rollers is the Cornish Roll, which consists of two iron rolls varying from 9 to 50 ins. in diameter, and from 9 to 18 ins. face; their spindles are connected by strong spur wheels and revolve slowly against each other. The shaft of one roll is in stationary bearings, the other being in sliding blocks acted on by regulating heavy springs or weighted levers, so that a uniform pressure is maintained between the faces of the revolving rolls to crush the rock introduced between them. The rolls are fitted on the outside with shells of hard iron or steel, and these can be replaced by new ones when worn out. Of late many rolls have been built without the spur-wheels connecting the spindles, but each run independently by large belt pulleys, as may be seen in Messrs. Fraser & Chalmers' "Old Style" Belt Rolls. These can be run at a higher speed than the geared rolls, and are now much more generally used.

A set of eight of Messrs. Fraser & Chalmers' "Standard" Crushing Rolls, built for Helena & Livingston S. & R. Co., is illustrated in Fig. 46. The rolls are mounted upon a solid base all in one

piece. The bearings of one of these rolls are framed in one piece with the heavy base, and the bearings of the other are mounted in slides planed in the same base. Nests of powerful springs hold the rolls truly to their work with a uniform crushing pressure. The rolls are extra heavy with large journal surfaces, and at the same time the necessary flexibility is secured by mounting them in boxes which have finished cylindrical bearings in the frame. The nest of springs do not have to be disturbed for the removal of the shells, rolls, or spindles; their position is stable and unaffected by such changes. The feed-hopper is provided with inclined baffle-plates, which distribute the material to be reduced so as to furnish a more even feed. The housing covers the rolls neatly, preventing dust from getting into the atmosphere or to the bearings. It is provided with plates and springs bearing against the inner sides of the frames, so that the housing has an adjustment to conform with any movement of the roll bearings when these shift in their cylindrical seats, and thus remains dust-tight in any case.

Krom Rolls.

These rolls were introduced by Mr. Stephen R. Krom, of New York, and are manufactured in England by Messrs. Bowes-Scott & Western, Ltd., of Westminster, London. The machine, as manufactured by them, consists of two sets of cast-iron rolls on steel spindles. The rolls, which are covered with steel tyres, vary from 26 to 30 ins. in diameter, including the tyres, the latter being made of the best open-hearth steel; they are $2\frac{1}{2}$ ins. thick on the 26-in. rolls, and $2\frac{3}{4}$ ins. thick on the 30-in. rolls, and can be worn down to $\frac{1}{2}$-in. thickness with safety. They have been worn as thin as $\frac{1}{4}$ of an inch, but there is then the danger that they will spring and become loose. Fig. 47 is a reproduction of one of these rolls. The bearings of one of the rolls are firmly bolted to a bed-plate by bolts and nuts. The second roll is carried in swinging bearings, fixed in two strong cranks, which rotate in a journal provided in the cast-iron frame. These double cranks are of the same width as the rolls. The shaft which supports them is 11 ins. diameter.

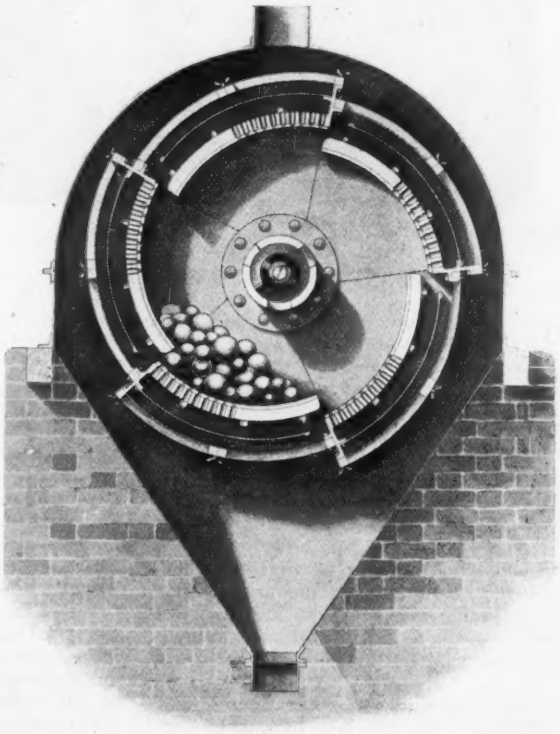


FIG. 45.—TRANVERSE SECTION OF MESSRS. BOWES-SCOTT AND WESTERN'S PATENT BALL MILL.

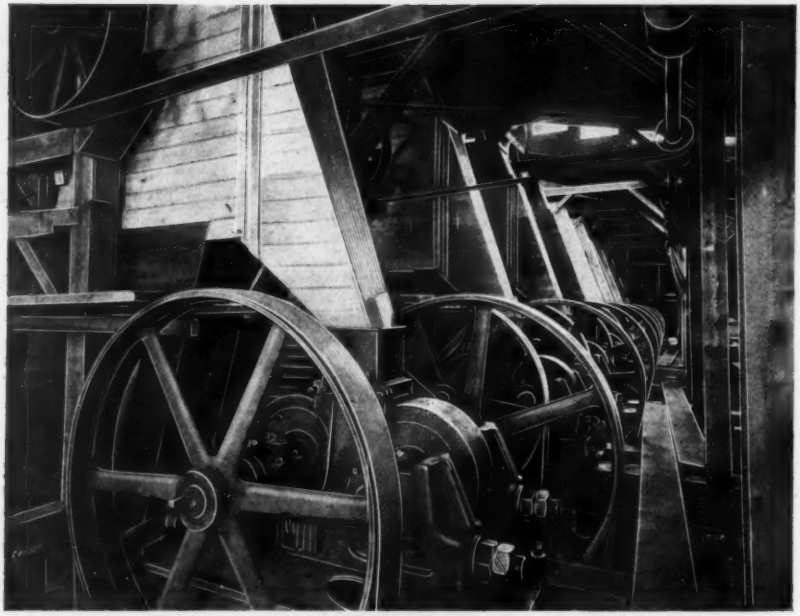


FIG. 46.—SET OF EIGHT CRUSHING ROLLS. BY MESSRS. FRASER AND CHALMERS, LTD.

The bearings are therefore pivoted with those of the rolls, and the two are thus forced to move together, so that this roll and spindle are always parallel to the other roll. The distance between the two rolls is regulated by screws, one on each side, with lock-nuts to prevent any motion after they are once set. The rolls are held in their position by two heavy bolts, also with lock-nuts, so that the position being fixed, the distance of the surfaces cannot be changed by any action of the machine but the wear of the rolls. Formerly the distance was fixed by having the bearings slide on the bed-plate, but this was found not to work well, as they constantly became loose and thus knocked on the bed-plate. It was also found almost impossible to get the surfaces of the two rolls parallel, and they were uneven. To the spindle of the fixed roll is keyed a large driving-wheel, 7 ft. in diameter and 15 ins. wide, and to the movable one is keyed a smaller wheel, 50 ins. in diameter and 8 ins. wide. The rolls are covered with a housing, to which an exhaust fan is attached, so that no dust escapes into the air; this protects the journals of the machine from abrasion. This housing carries a feed-box, arranged with a series of incline so as to spread the ore in a continuous and even sheet between the surfaces of the rolls. Magnets are provided in the feed-box to catch any pieces of steel which may be in the ore from broken tools, and which might indent the surface of the rolls.

Corrugated rolls are used to some extent in Australia, but though the crushing surface is increased in this way, they are considered in the United States to be of little value, wearing unevenly and soon getting out of order.

The method of crushing usually adopted is described in the following manner in the excellent book, "Metallurgy of Gold,"

by T. Kirke Ross, D.Sc. :—"It may be supposed that the ore is to be passed through a 20-mesh screen. The ore is put through a rock-breaker, and passed at once to classifying screens, by which it is divided into four classes of material. One of these consists of ore that pass a 20-mesh screen, and this amount (usually small) is separated as finished product; another small portion is returned to the rock-breaker by some form of elevator, being too coarse for the rolls, and the greater part is passed to one or other of two pairs of rolls. Each of these pairs of rolls is occupied with crushing material of a particular degree of fineness, reducing it to a further degree of fineness. The material fed to them is classified accordingly. After each passage through the coarse rolls a certain amount of finished product is obtained, and the remainder is classified, part being returned to the same rolls, and part being sent on to the fine rolls, the product from which is also classified. Revolving screens are in general use for classifying. The use of two rock-breakers, one for coarse crushing, and the other to take its product and reduce it to the size of broad beans, is often recommended. The number of pairs of rolls to be used in succession depends on circumstances—two is the usual number, a third pair being occasionally added. One rock-breaker and two pairs of rolls will suffice for the reduction of most ores to a size sufficiently fine to pass through a 30-mesh screen, but the crushing can be done more economically in the long run by still more gradual reduction."

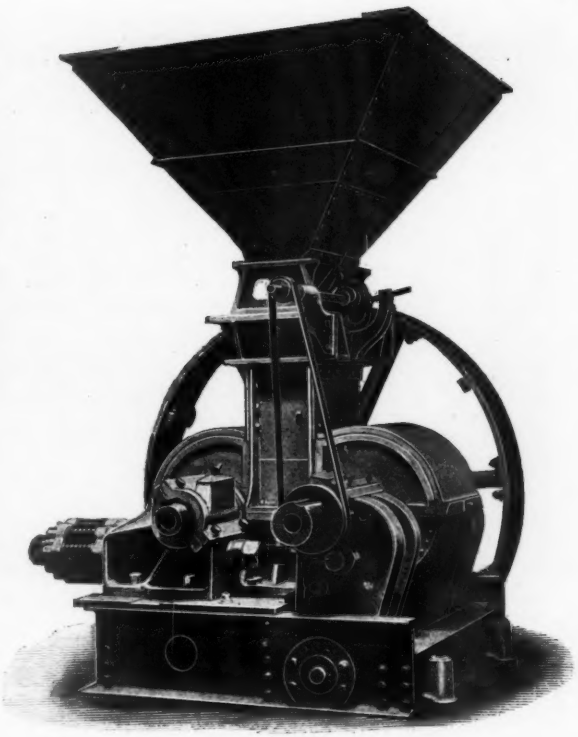


FIG. 47.—A "KROM" ROLL. BY MESSRS. BOWES-SCOTT AND WESTERN, LTD.

(*To be concluded.*)

Philip R. Björling

British Commercial Supremacy.

By ERNEST D. PHILLIPS.

MR. PHILLIPS, during the course of his school career, secured many prizes and awards in various sciences. Leaving school, he entered as an articled pupil in a small general electrical engineering works in Lancashire. Three years were then spent as electrician in charge at electric lighting works.

In 1895 he secured the First Prize in Electric Lighting and Power Distribution, Honours Grade, being awarded the City and Guilds of London Silver Medal and Goldsmiths' Company's Prize.

He spent three years as assistant in the Electrical Engineering Department of the Central Technical College, London, being lecturer on Electric Power Distribution, and taking charge of many kinds of electrical experimental work.

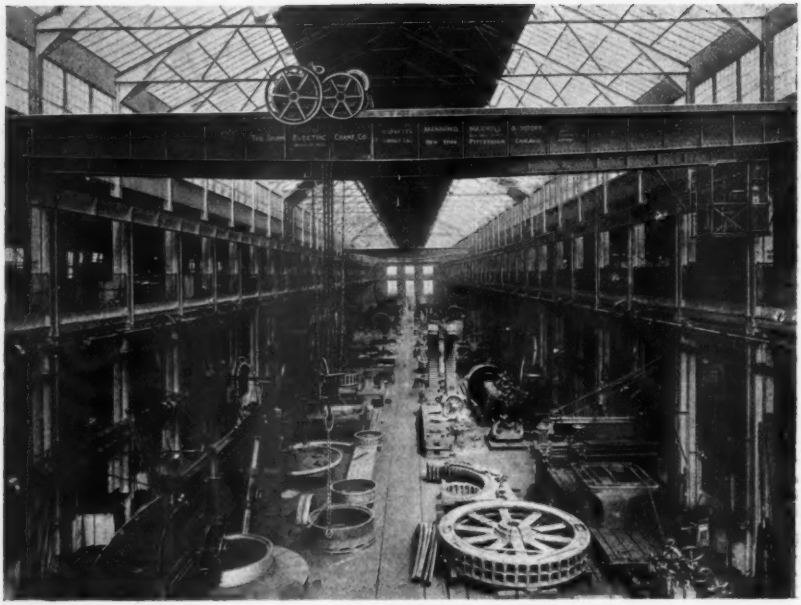
He is a frequent contributor to technical and other publications, and the position he now occupies entitles him to speak authoritatively on the subject of the comparative methods of British and American practice.

IT is not intended in this article to weary the reader with a reproduction of Blue Book statistics. One has, however, only to compare the figures contained therein for the past few years to see what is happening to British trade, including engineering. It has been repeated over and over again during the past four or five years that the tide of British engineering was no longer flowing, but slowly, surely ebbing. There are none who can conscientiously deny the statement now. Naturally, there were many who cried out in the beginning, when our decadence was first noted, that it was only a slight hitch in our progress due to an abnormal sprint on the part of some young competitor who would be unable to keep the momentary lead; that Britain, the acknowledged ruler of the world's commerce, held a position perfectly unassailable. There is no doubt that such ideas if persisted in by Britons will most certainly lead to Britain's commercial downfall. It is exactly this easy form of reasoning which has left us behind other civilised countries in many directions, especially electric power distribution, traction facilities, and labour-saving devices.

At the same time technical education has been neglected, and is looked upon by many as unnecessary. It is far too commonly heard, "Our fathers held the lead without it, and so can we;" all innovations are looked upon with suspicion.

In certain cases "the new system" is blamed because where tried it did not immediately prove to be a great financial success. It is rarely noticed that this may be due to the lack of "go" of those who tried it and who failed to use their whole energy for the purpose of obtaining the best possible results; or that the men into whose hands the control of the experiments has fallen are altogether unfit for such a responsibility, since they have been educated in the old school, and cherish its prejudices.

In other hands success has resulted from these experiments, and a real advance move has been made, yet this advance has been



A TYPICAL EXAMPLE OF THE MOST MODERN PRACTICE IN ENGINEERING WORKS. THE MAIN AISLE OF THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY'S WORKS, PITTSBURG, U.S.A.

very slow. The Briton hardly knows what it is to "boom" anything and proceeds with great caution. This caution is praiseworthy, but England has, after all, not gained her supremacy by waiting for other nations to move, and then adopting the outcome of their successful experiments. This supremacy has been due to her own energy, genius and initiative. Has she lost any of these qualities? By no means. Her people have still energy and genius which equal or surpass those of any nation; but what of the third quality? Are we still ready to take the lead?

Confining the scope of this article more particularly to a comparison between England and the United States of America, which is certainly our most dangerous competitor in the engineering field, a few plain truths may help to answer this important question.

In the first place, it is noticed that America is populated with men who are in the strictest sense of the term pioneers, or the descendants of pioneers, of not more than two or three generations ago. Each one settled in the new country with the fixed idea of making a fortune. Generally speaking, he was a man prepared to work his hardest and put up with every kind of inconvenience, and to rely for success upon his own ingenuity. Self-reliance and ingenuity were the dominant characteristics required of the pioneers, and these peculiarities were developed and inherited by their children, who themselves found constant exercise for them in a country so full of undeveloped resources. Thus these characteristics gradually became national characteristics; and even after the country had settled down to what might be termed a definite population, its inhabitants remained distinguished by just those qualifications that rendered them dangerous rivals to older nations, since they pos-

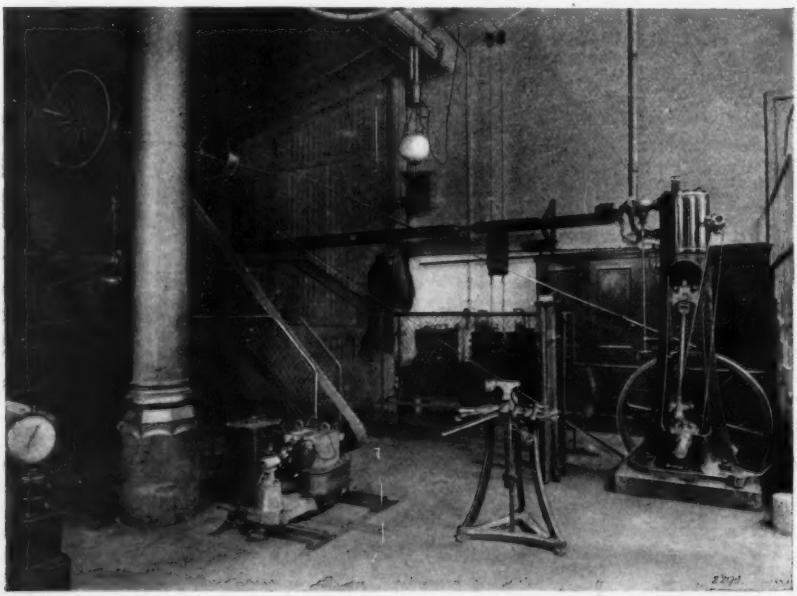
sessed all that was needed to successfully compete with them, namely, greater resources and more energy and adaptability.

The output of the American industries soon exceeded the needs of the nation, and the latter began to work with the definite object of supplying outside markets. We all know with what success. But, in the meantime, what had been happening in England, the old leader of commerce, during the period that this young claimant for leadership was gathering strength? Had the old veteran of many hard battles been resting idly on his laurels? It would rather appear so. Many times during the past few years had he been warned of the impending revolution, and advised to copy the tactics of his young rival. He resented, however, this advice. Why should he copy the upstart? His own methods had been successful so many years; why then should he adopt a new system? If he continue to hold these ideas much longer he will find himself rudely shaken one day, and his stubbornness will lead to a crisis which will be the means of eventually dethroning him.

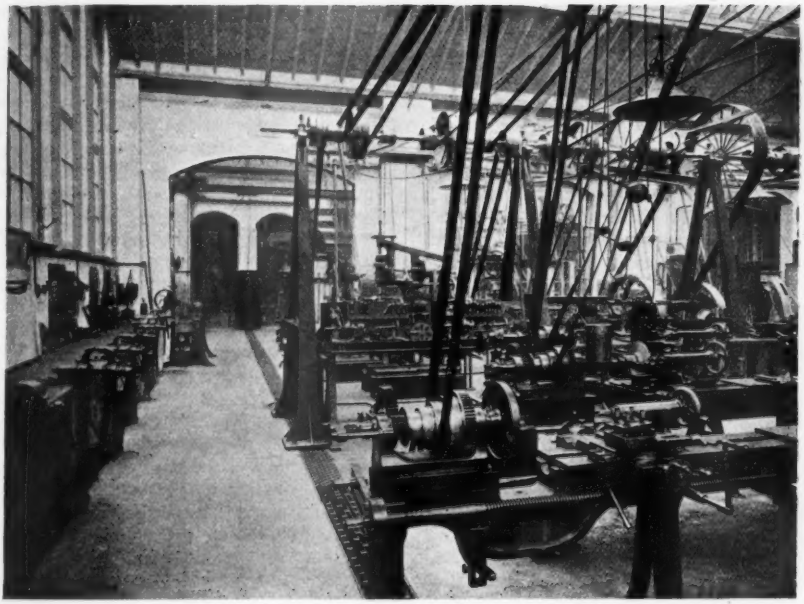
America, as a young country, has many advantages over Britain. Instead of having to pass, for instance, in her traffic facilities, through the successive stages of engineering, such as bridle-paths, turnpike roads, to railroads, or in her use of power, from hand power to wind power, steam power, and finally electric power, she began with railroads and electric power, *i.e.* she started from the point at which Britain seems to have thought it fit to rest, believing herself perfectly secure for all time.

Comparing some of the main principles adopted in the important engineering works of America and England, one cannot fail to be struck with the great differences existing in the engineering practices of the two countries.

The largest firms of America make a speciality of the sole production of one



VIEW SHOWING SOME OF THE APPARATUS IN USE AT A REPRESENTATIVE BRITISH TECHNICAL COLLEGE.



ANOTHER VIEW SHOWING SOME OF THE APPARATUS IN USE AT A REPRESENTATIVE BRITISH TECHNICAL COLLEGE.

article or part of an article. They will not take any order except for their standard production, and they pride themselves on this, looking down upon those who undertake to produce anything from a kitchen-range to a threshing-machine, or from a copper-kettle to a dynamo. If an American should feel inclined to produce other articles besides his specialty, he sets up a separate works for the production of each.

The advantages of this system of subdivision are many. From the manager downwards the entire control of a works is in the hands of experts in each particular branch of manufacture. Special machine tools are used wherever possible, ensuring rapid and duplicate work. The machine tools and other equipments are obtained from firms who manufacture these specialities. It is important, moreover, to notice that a sharp look-out is always kept for improved machines. No machine is too good or too expensive for the American manufacturer, and he does not hesitate to put upon the scrap-heap the most expensive machine as soon as he learns of another type that will reduce the cost of production or improve the quality of the work. It is evident, of course, that large profits must be made to pay off such scrap-heap losses.

Not only as regards the use of machine tools, with their labour-saving, accurate-working, and quick producing properties, does America differ from Britain, but also in other improved methods.

To mention one example, the arrangement of the buildings and plant is a point which, it will be seen, is well worth taking into account when production of a certain article is the sole object of the works.

Thus, for instance, in the manufacture of engines or dynamos, the raw materials enter at one end of a long building divided into sections, and are passed by power-operated cranes, step by step, from one department to the next, until the opposite

end of the building is finally reached by a perfectly finished product. There is no time wasted in carrying certain parts backwards and forwards between various shops. The machine-tools, fixed and portable, are all arranged in consecutive order to take care of their special parts as the work passes through. All parts are thoroughly tested as they are produced, and of course the finished article is submitted to stringent actual-working tests before it passes from the works.

Economy is another feature of American working methods. The American engineer knows that there are cheaper and more convenient ways of operating his machinery than by using several individual steam engines about his works with their wasteful lengths of steam piping, heavy shafting and belting—notoriously inefficient and old-fashioned methods which the British engineer, as a rule, is so devoted to. Many pages of statistics dealing with the question of savings and losses, resulting from one or the other methods, are constantly being brought to the notice of the British engineer. In technical journals, newspapers, and magazines he constantly meets them. At scientific and other meetings they are pointed out to him. This has been so for several years past, but how many have given this all-important subject more than a passing thought? Few, very few, and even fewer have taken any action to improve matters. Is it because the majority are imbued with the idea that since their father made his fortune by working in a certain way, they are bound to follow to the very letter their father's methods?

The English engineer knows as well as any other that electricity is an economical agent to employ in his works; the American not only knows it but has adopted it. He uses it for every kind of manufactory. In factories of gunpowder and other explosives, in coal-mines, flour, cotton, oilcloth, and all other mills, and even in the shops of butchers and other tradesmen, electric power is in very general use. In order to induce Americans to introduce electricity in their engineering works it was sufficient for them to know that by using electric motors with discretion, machines can be arranged in such an order and driven at such speeds that the greatest possible amount of work can be successfully done by them. Electric motors, working independently of each other, are stopped and started with facility; there are no idly-running losses of power. Motors may be set on the ground, below the ground, hung on the wall or suspended from the ceiling, and therefore do not occasion any unnecessary waste of space; they require no expert or special attendance, and should any machine or motor break down, none—or no great part, according to arrangement—of the other machines are affected thereby. The centralisation of the power plant, the small attendance it requires, the economy of power distribution along electric conductors, the efficiency of generators and motors, and the economy and suitability of the works' lighting supplied by the same means, are all factors of great importance in reducing the actual cost of the energy unit, and enable our American competitors to undersell us. Other noticeable differences are to be found in the character of the workers in the engineering shops of Britain and of America. In the first place, the work of the majority of employés in America is confined to the superintendence of machine tools, and is a special class of work. There are very few "fitters." In the second place, the efficiency of the work-people is considerably enhanced by the improved surroundings and sanitary conditions under which they work. In electrically operated works, belts, loose pulleys, counter-shafting and gearing, with their dangerous, noisy, dirty, and light-obstructing qualities, are dispensed with as far as possible. The men work in daylight, and when night falls the best of lighting, electric, is used. The providing of a separate clothes-locker for each worker, washing conveniences, and a substantial mid-day meal at less than cost price, are all important features of American engineering works. The individuality of each employé is fully recognised and encouraged; he is clean, works in cleanly surroundings, has his own particular round of duties to attend to, and is conscious of his own worth. Little wonder then that he pro-

duces the maximum amount of work. It might be thought that no great skill would be required of the operatives controlling machines which do the work of the most skilled mechanic; but skill is required to keep the machine up to its maximum output and accuracy of working, and both require constant observation and long practice. The intelligent man is ever on the look-out for possible improvements, and for this reason American masters encourage, and listen to, the ideas which any worker, no matter what his position, may have regarding improvements or invention. Many important advances in engineering practice have sprung from such lowly sources, and in America the originator is not without reward.

It must not be thought that the American as a man is superior to the British worker. Far from it. In Britain the average mechanic, though working in unhealthy, dingy shops, is yet able, by slaving all day long at his task, to keep up a good home and make a profit for his employers. If he is able to do that now, what would he accomplish if the works were modernised? All he lacks are opportunities and means to show his worth. He has education in the wide sense of the term, and whilst training his intellect it has not been at the expense of bodily vigour.

There is however, an even wider difference between the masters of Britain and America than there is between the workmen, for it is the British employer that stubbornly adheres to obsolete methods.

Generally speaking, the British engineering works are big profit-earning concerns. Trade is brisk, and in many cases orders cannot be taken for delivery in a reasonable time, with the result that customers are often compelled to place their orders with American firms.

The manufacturing engineer of Britain does not mind and is satisfied as long as his own personal needs of to-day are amply satisfied. This short-sighted policy will not allow him to grasp the idea that if his prosperity is to continue, he must be more enterprising and be abreast of modern practice.

Also in the matter of technical education Britain moves very slowly, and there can be no doubt that this has had a great deal to do with our commercial backsliding.

Probably in no country is technical education carried out to such an extent and with such good results as in America.

Much good work, it is true, is accomplished by the few Technical Colleges and Schools which Great Britain possesses. The evening classes held in some of them are certainly useful in perfecting the training of artizans, and as such they are worthy of all support. But it is beyond the capacity of the average workman to put in nine-and-a-half hours of manual labour during the day and then apply himself to, say, three hours of severe intellectual study in the evening.

As regards technical colleges proper, however—*i.e.* colleges laid out for the special purpose of training young men in the most advanced methods and practices in certain specific branches of industry—Great Britain is but poorly supplied. There are only two or three technical colleges which have any good reputation. These consequently are always full, and, moreover, are so hampered for want of monetary support that they are rapidly falling behind in their results.

The best men in their respective professions should be engaged as instructors, and the most modern plant, machinery and general equipment are absolutely necessary if good work is to be done in our colleges and the country is to be benefited by their presence. No money could be better spent than by investing it for such a purpose.

Let Britain therefore train her young men to become experts in engineering, and let her take a lesson from those countries who are fast outstepping her in the race, if she wishes to recover lost ground; and let her manufacturers adapt themselves to the progress of the age.

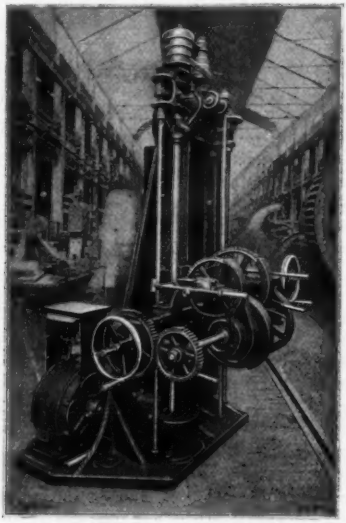
Each proprietor and manufacturer ought to bring his works and his methods up to date, as has been done by his successful rivals.

Each workman ought to follow the practices of those who are the most efficient and prosperous in similar trades or avocations in other countries. He ought, for instance, to abandon such ideas as the

one-man-one-machine rule, and remember that in America one man may work as many machines as he is able to, that he works on a certain system of piece-work, and that the results of these American methods are—a better rate of wages, happier and cleaner forms of work, employment for all, and greatly increased prosperity for the employé, the employer, and the nation.

Let each man of Britain, whatever his calling in life may be, ever bear in mind that his country and empire depend for their supremacy among nations upon his individual exertions to improve his position. Then will the British nation shine as a beacon guide to others in the twentieth century as it did in the nineteenth.

ERNEST D. PHILLIPS.



A PORTABLE DRILLING, MILLING, AND BORING MACHINE, ELECTRICALLY OPERATED, AS USED IN THE ADVANCED AMERICAN SHOPS.

MACHINERY APPLIANCES AND PROCESSES.

"Every part and side of our life, from the cradle to the grave, has been touched and tended by the inventor and manufacturer. His works are as numberless as the sands of the sea, but the onward rush of Science and the Arts opens up new fields of discovery and enterprise as each day dawns. Let us choose here and there among thousands, and in choosing take the best as far as in us lies."

REOPENING OF SOME EARLY ROMAN COPPER AND LEAD MINES IN TUSCANY.

SOME reports recently reached the office of FEILDEN'S MAGAZINE that as a result of the exploration of some old Roman copper and lead mines in Tuscany some very rich and extensive lodes had been discovered in the neighbourhood of the old workings. The demand for copper is now so great in consequence of the development of electric power transmission schemes for traction and other purposes that fears have been expressed in many quarters that before long we should have a copper famine, and that the present high price of that metal would be indefinitely increased. The discovery of fresh workable lodes in accessible positions is therefore a matter of the greatest interest to many of our readers, and a special commissioner was instructed to make a personal examination of the mine and its capacities, and the courtesy of the engineer and owners has enabled us to supplement the verbal description by the excellent photographs which are reproduced in the following pages.

Between San Vincenzo and Campiglia there rises, from the main line of railway between Pisa and Rome, which here runs close to the shore of the Mediterranean, a range of limestone hills, consisting to a large extent of white marble. On the southern slopes of these hills, at a distance of from two to three miles from the shore, are some old Roman copper and lead mines. The ruins of early copper smelting works are still to be seen at the base of the hills, close to the shore, with large quantities of débris consisting of slag from the smelting works, and much of this slag has within comparatively recent times been found to contain a sufficient percentage of metal to enable it to be resmelted with profit. The miners of early times invariably started their shafts and quarrying operations at a spot where the lode was met by a porphyry course, and, instead of ascertaining the position of a lode and sinking a shaft, or driving a tunnel right through it, as is now done, they always began their work just outside the wall, in the angle formed by the junction of the Elvan course, and the lode opening out usually a fairly large quarry to a depth of some forty or fifty feet.

From the bottom of this quarry they used to drive narrow tunnels obliquely down to the lode, and when they struck ore, which

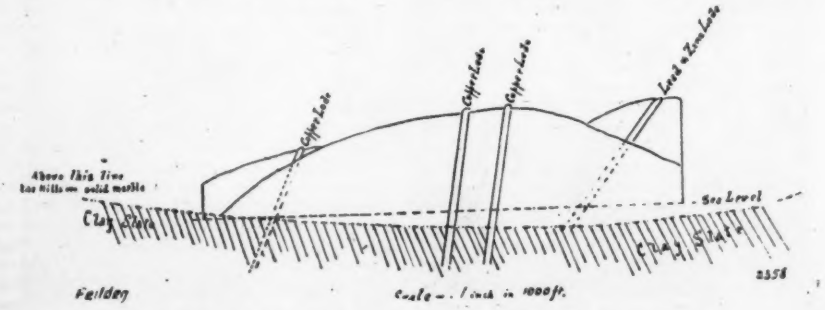


FIG. 1.—ETRUSCAN COPPER AND LEAD MINES.—GEOLOGICAL SECTION SHOWING LODES.

FIG. 2.—ETRUSCAN COPPER AND LEAD MINES.—HEAD OF SHAFT SUNK INTO ONE OF THE GREAT COPPER LODES.

here they seem to have done in nearly every case, they discarded all the lower grade material, following up the bunches of rich ore from point to point in devious courses, until they lost track of them or until these narrow tortuous tunnels became too long for the ore to be profitably raised to the surface, when the old workings were abandoned and new ones opened up.

These desultory methods precluded any great depths being reached, and as these copper lodes are all iron capped, and the old workings never got below the iron caps into the true lode, the richness of the ore as shown by the slag is most remarkable.

Within the last hundred years one or two spasmodic attempts have been made to look for ore on the estate, but it is only quite recently, since the estate has been purchased by some Englishmen, that any systematic survey and plan of working has been attempted.

Four lodes of copper in the form of sulphide, and one of lead and zinc in the form of galena and zinc blende respectively, have been found. The two largest copper lodes and the lead zinc ore have been surveyed and are now being worked. The four copper lodes all extend horizontally for a distance of over three-quarters of a mile, and the width of the two large ones has been determined at different places at varying depths from the surface down to 130 ft. below it, and the minimum width found so far has been about 120 ft. and varies from this up to about 160 ft.

The entrance to the shaft, now 130 ft. deep, which has been sunk into one of these copper lodes, is shown in Fig. 2. The quarry excavated by the early Roman miners is visible on the left-hand side.

They are all true fissure lodes forced up through a groundwork of clay slate overlaid by a bed of white marble varying from 400 to 600 ft. in thickness as shown in Fig. 1, which represents a geological section through these two lodes. All the four lodes have iron caps, and although the shafts have not yet got down to the true lodes beneath the caps ore has been extracted which has assayed as high as 22 per cent., and so far practically all the material taken from the shafts and tunnels through the iron cap is rich enough in copper to pay well for

smelting. Those of our readers who are mining experts will realise the extraordinary significance of these figures, which indicate a wealth only approached by such mines as the Rio Tinto, Spain, Broken Hill in New South Wales, the Montana Mine in the United States, and the Mount Lyell Mines in Tasmania.

Some of the lead ore was also taken out by the Romans from the surface, and some two hundred years ago some small lead-smelting works were established in the neighbourhood of the mines and were worked for a few years. This lode, like the copper ones, is a true fissure lode forced up through the same strata. Only about a quarter of a mile of the lead lode has hitherto been surveyed along the surface, and its width varies from 97 up to 137 ft., a lode of a size just as extraordinary as in the case of the copper.

A portion of the outcrop of this lode is shown in Fig. 3. The top of the hill rises about 400 feet above the place where the men are standing.

At the time of my visit the quantity of ore exposed to view was not less than 200,000 tons. This lode has been struck by a tunnel driven at a depth of 200 ft., averaging at least 10 per cent. of lead and 10 per cent. of zinc, much of the zinc ore being almost unmixed blende. Fig. 4 shows the entrance to this tunnel, with a heap consisting of some 2,000 tons of ore on the right-hand side. The chief engineer of the mine informed me that no traces either of antimony or arsenic had been found in the zinc blende, a matter of very great importance, as they are extremely deleterious and difficult to separate when present. Another important point is that the copper lode is quite distinct from the lead, and does not contain either lead or bismuth.

The property covers some 1300 acres, and the ores, besides existing in such enormous quantities, are so easily accessible and workable from different points that the output will only be limited by the amount of plant and labour employed. I am informed that the owners are ordering the machinery as fast as the plans can be made out, and that they intend to push on the development as rapidly as they possibly can until at least 10,000 men are employed.

In several respects the work will be carried out under exceptionally satisfactory econo-

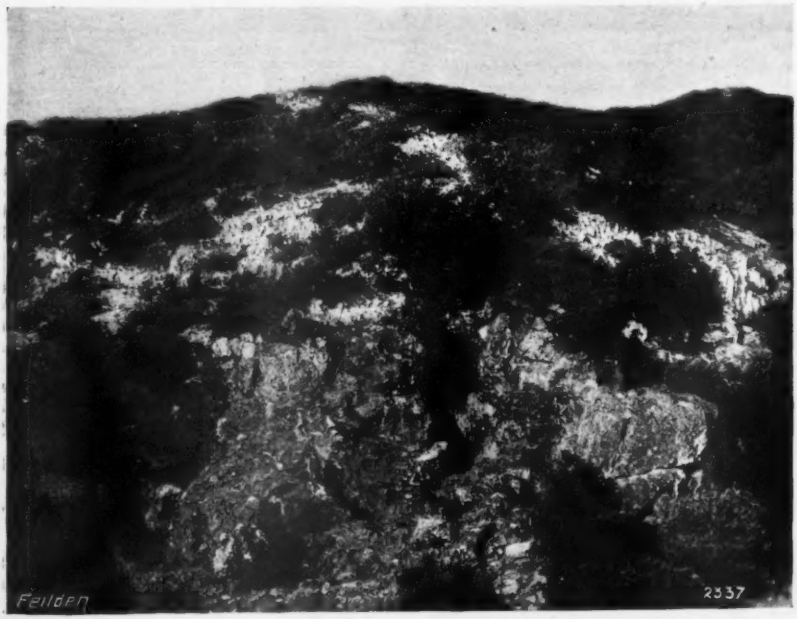


FIG. 3.—ETRUSCAN COPPER AND LEAD MINES.—VIEW OF AN OUTCROP OF THE LEAD LODE.

FIG. 4.—ETRUSCAN COPPER AND LEAD MINES.—ENTRANCE OF TUNNEL INTO THE 110-FT. LEAD LODE.

mical conditions. Labour is plentiful and cheap, and the railway siding will be close to the estate with easy access to the sea. The cost of building will be low, both on account of the cheapness of labour and the unlimited supply of marble and other building material on the estate. Then again the nature of the rock renders timber supports unnecessary in the shafts and tunnels, and obviates the necessity of pumping, as there is no accumulation of water in the mine, while the oxide of iron and limestone fluxes required for reducing the ores are ready to hand on the estate.

Coal is at present expensive, being brought from Newcastle, but there are large beds of lignite within ten miles of the estate and it is intended to utilise these at an early date.

WRIGHT'S PATENT TAPER ROLLER BEARINGS.

Of late years, many attempts have been made to invent a system of bearings which would not only effect a considerable reduction of friction, but which would at the same time be applicable to vehicles of all sizes and weights. These efforts have, however, from various causes been not altogether successful. The ball-bearings, for instance, which have done so much to popularise the bicycle, are found in actual experience to wear unevenly and to crush under heavy weights. Their use is consequently limited to light vehicles.

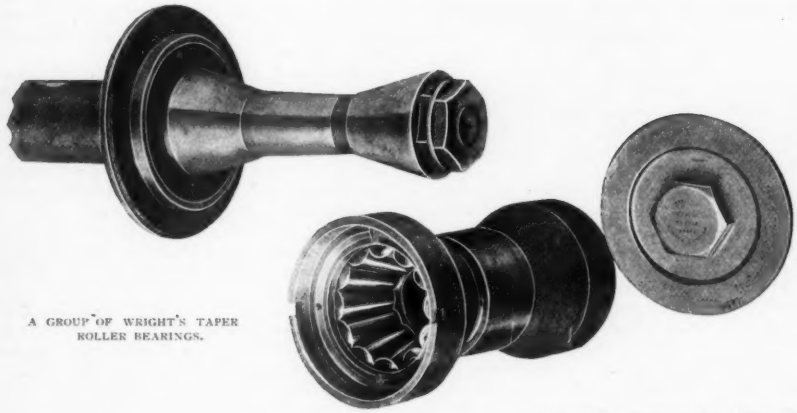
Judging from trials extending over a period of eighteen months, Wright's Taper Roller Bearings appear to overcome these difficulties. As the name indicates, these bearings consist of taper rollers, of which two sets are fitted to each axle, and these rollers revolve quite freely round the axle. Briefly, the special features claimed for these bearings are :—

1. They can be fitted to any ordinary axle, consequently they can be used on every kind of vehicle—gun-carriages, omnibuses, tram-cars, vans, motors, cabs, &c., &c.

2. They are sand and dust proof.

3. They wear evenly along their whole length, and are *adjustable* to correct any wear.

4. They show no signs of wear after months of use.



A GROUP OF WRIGHT'S TAPER ROLLER BEARINGS.

5. They can be adapted to stand any weight, and have been tested up to 10 tons.

6. Lubrication is reduced to a minimum.

7. Wheels fitted with these bearings can be taken off and replaced with the same facility as ordinary wheels.

8. Wheels with these bearings are now so made as to be interchangeable with ordinary wheels. This is most important to tramway and omnibus proprietors, as in the event of a breakdown an ordinary wheel can be slipped on to replace the defective wheel.

9. Lastly, these bearings are proved by exhaustive and independent tests, to secure a reduction of at least 50 per cent. in the starting strain.

For military purposes, the use of these bearings would go a long way towards solving the question of increased mobility, as a reduction of 50 per cent. in the draught strains means doubling the mobility with the present horse-power. These bearings will fit any Government axle, and can, therefore, be fitted to ambulance, forage, ammunition and other wagons. These bearings will stand the roughest usage, as has been proved by the Bucks Yeomanry, who have had a gun-carriage fitted with them in constant use for the past twelve months. Although this carriage was put through a specially severe series of trials by being driven over tree trunks, brickfields, &c., the bearings show no signs of wear. In the Navy, seeing that the field guns are always drawn by hand-power and that the number of men on board ship is always limited, the use of these bearings appears even more desirable.

In omnibuses and tramcars these bearings would reduce the terrible starting strain which wears out the horses so quickly, and is the cause of so much struggling and suffering to the animals.

Lengthy electrical tests over all sorts of gradients show that the saving on the running strain, as distinguished from the starting strain, is about 20 per cent.

From a close inspection made by one of our representatives we have no hesitation in confirming many of the claims advanced for this apparatus.

Interested readers should communicate with the Secretary, Wright's Taper and Roller Bearing Syndicate, 1 and 2, Great Winchester Street, E.C.

AN IMPROVED MOTOR CONTROLLING-SWITCH.

THE large and constantly increasing use of electric motors for driving purposes has created a demand for reliable and safe automatic starting and controlling switches.

To meet this demand various firms have introduced motor switches, many of which are good, but one just perfected by Messrs. John Gibbs & Son, Liverpool, possesses special features of interest.

As can be seen from the illustration given below, the regulating arm is interlocked with the double pole switch in such a manner that it is impossible to close the double-pole, unless the regulating arm is in the position where all the resistance is in circuit. The double-pole switch can, on the other hand, be broken in *any* position of the regulating arm. To prevent switching on with undue speed the regulating arm is fitted with a speed-reducing gear, rendering it impossible to cut out the resistance too quickly. In addition to this a combined spiral spring and electro-magnetic clutch arrangement has been so devised, that whilst the regulating arm will remain upon any desired contact stop while the current is flowing, the arm flies back to the primary position immediately the circuit breaks, thus obviating any possible danger from the current being switched suddenly off and on.

In addition to this the switch has an overload magnetic cut out which can be adjusted to come into action whenever the current exceeds any given amount.

The switch can also be fitted with fuses if required, and is therefore as complete as it can well be.

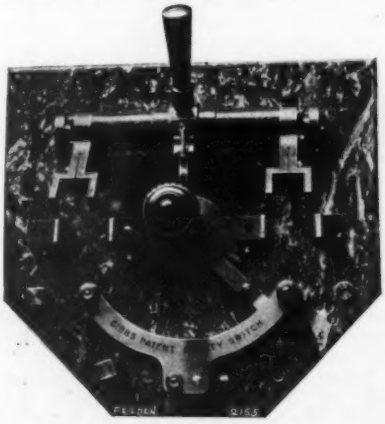
All parts of the switch are of ample proportion for the work to be done and mechanically strong. The resistance when it is used as a starter only can be carried in a neat iron box mounted above the switch itself. If used as a regulator leads would be taken to a separate frame mounted in some convenient place.

This switch has met with the approval of all competent authorities who have yet seen it, including some of the first in the country.

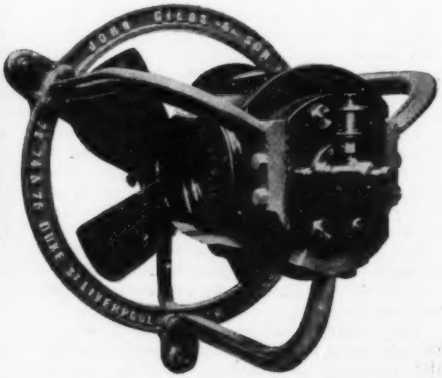
Another speciality recently introduced by Messrs. J. Gibbs & Son is a fan driven by a perfectly enclosed and water-tight motor, which is designed to meet the special requirements of ship and mine work. The illustration we give will enable our readers to form a fair idea of the appearance of this machine. The motor itself is of similar type to the one introduced by Messrs. Gibbs for driving their patent electric fans, which motor is dustproof, but the case is a cast one of brass or aluminium fitting steam-tight on to the yoke or base of the machine. The spindle runs through a stuffing box, and the windows for inspecting the motor are made very strong, and whilst instantly removable are perfectly watertight.

The tests of this motor show that whilst the case is perfectly watertight prolonged running does not cause the machine to heat above the Admiralty limits.

The bearings of the machine are self-adjusting, thus ensuring perfect alignment and easy running.



IMPROVED MOTOR CONTROLLING-SWITCH.



FAN DRIVEN BY AN ENCLOSED WATERTIGHT MOTOR.

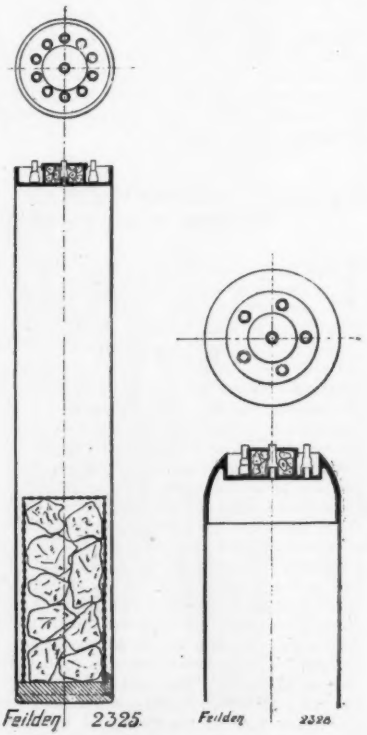
A NEW MARINE TORCH.

MUCH inventive genius is at the present time being directed to the application of the wonderful illuminating properties of acetylene gas to purposes hitherto but imperfectly accomplished by other means. It has long been recognised that some powerful form of light, which could be set in action at a moment's notice, would be of the very greatest utility at sea, after darkness sets in, both for life-saving service and also for use in Naval warfare. For the former purpose we are at present confined to the use of rockets, coloured lights, untrustworthy petroleum floats, and on rare occasions the electric search-light from shore or on board. Even the International Regulations and the Board of Trade, having known nothing more brilliant, require, for danger signals in case of collisions at sea, lights such "as from a burning tar barrel, lasting several minutes"; while for the latter the search-light is the only means at our disposal for warding off torpedo attacks, or lighting up harbours or an enemy's fleet at night. The search-light only secures immunity from attack within the limited space upon which its beams fall, and it is therefore necessary to have its light constantly scouring the ocean in all directions for its services to be of any great value.

Within the last few months, an invention has been put upon a practical and commercial basis which has for its object the employment of independent floating torches, which instantly become ignited when brought into contact with water, and will keep burning even though continually submerged by heavy seas.

From the day that carbide of calcium became a commercial product, the fact that it would generate the gas acetylene when brought into contact with water caused inventors to realise the immense advantage which this powerful illuminant offered over all existing lights for use at sea, provided some means could be effected whereby the gas, when generated, should be automatically ignited with absolute certainty, and re-ignited if the flame was extinguished by rough seas. After many experiments had been made by Colonel W. J. Wilson, of Philadelphia (the original inventor), with metallic potassium as the igniting medium, Messrs. William H. Rose and G. R. Holmes, of Baltimore, together invented the Marine Torch as at present employed, and which has been found to be equally useful for all purposes where a brilliant light is required at sea. The torch merely consists of a plain hollow cylinder of metal; for ordinary marine uses sheet brass or tin is used, but for Naval purposes a 16- or 20-gauge drawn steel tubing, the sizes varying from 3 ins. to 8 ins. in diameter, and from 1 ft. to 5 ft. in length, according to requirement. The cylinder is sealed at both ends, and contains in a wire basket a quantity of carbide of calcium, from which acetylene gas is generated; it also contains an air chamber which gives buoyancy to the torch. At the head of the cylinder a number of burners are arranged, adjacent to which is a small chamber containing calcium phosphide, which, on contact with water, creates phosphuretted hydrogen and ignites the gas as it issues.

The torch possesses no mechanism or moving parts, nothing to cause disorder or failure, and requires no technical knowledge for its use. It is safely preserved for any length of time in a sealed metal case, or by caps similarly sealed, covering the burners and the inlets for the water, which, by the



DETAILS OF NEW MARINE TORCH.

simple device of a protecting strip of metal, to which is attached a ring, is instantly opened by hand; the torch has then only to be thrown overboard if its light is required; water then enters small holes near the base of the torch, and coming in contact with the carbide of calcium, instantly generates the illuminant. The gas issues from the burners and burns with such force that it is impossible to extinguish it by any natural or mechanical current of air, and the torch can be held more than four inches under water, *for its full life*, without being extinguished. If the torch is submerged to such a depth that it is extinguished, it immediately relights on coming to the surface, and this it will continue to do any number of times during the period the torch is constructed to burn.

A six-inch torch burns from an hour to an hour and a half, with a brilliancy of over 2000 candle power, and gives a flame of over 12 inches high. Other torches, which are rechargeable, will burn from half an hour to ten hours, according to size and requirement.

The representative for Europe of the Marine Torch Company, whose headquarters are in Baltimore, U.S.A., where the torches have been perfected, is Mr. Alexander F. J. Johnson, of Clevedon, Forest Hill, London, S.E., to whom any inquiries should be sent for further particulars.

800 I.H.P. COMPOUND VERTICAL ELECTRIC TRACTION ENGINE.

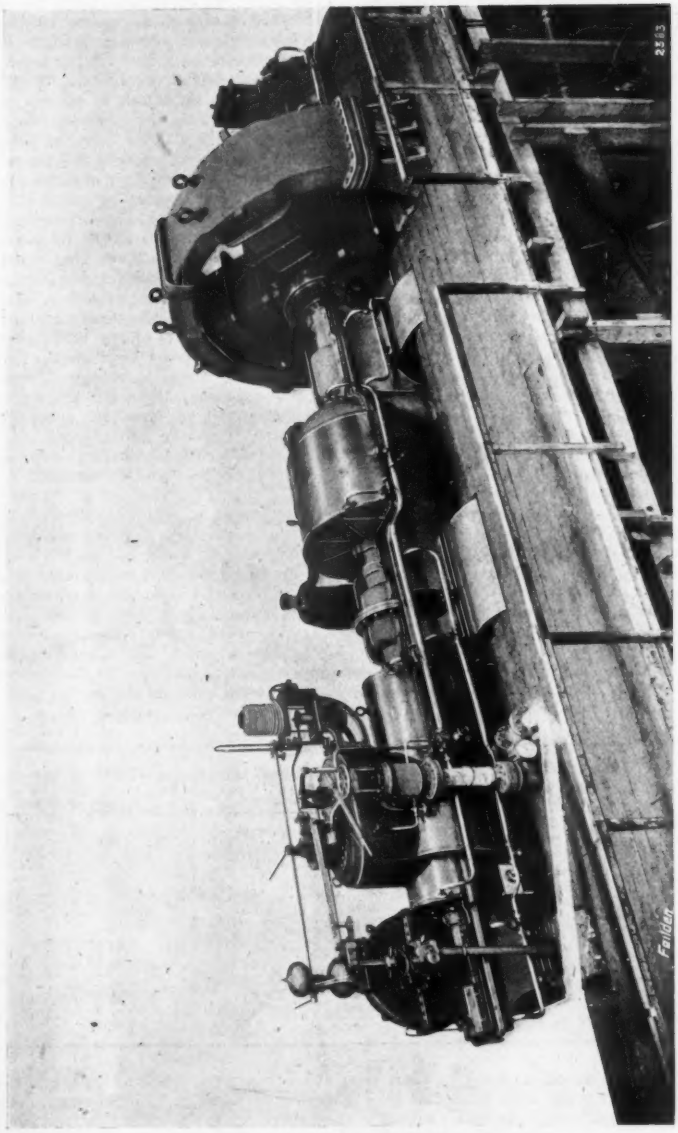
THE subject of the Supplement plate this month is one of the compound vertical engines recently built by Messrs. D. Stewart & Co., Ltd., Glasgow, for the Glasgow Corporation. These engines, of which Messrs. Stewart have made two for the Glasgow Corporation Tramways, and four others for Corporations in Western Australia, are of the vertical cross compound type and are for driving the 500 KW Tramway Generators which are mounted on the crank shaft between the high and low pressure parts of the engines. Each engine is capable of indicating up to 1,200 h.p. as an emergency load, and can run continuously on a load of 1000 i.h.p. at a slight sacrifice of economy. The steam cylinders are 22 ins. and 44 ins. diameter, by 42 ins. stroke. The normal steam pressure is 150 lbs. by gauge at the engine stop valve, and the speed at which they are designed to run is 90 revolutions per minute. The piston rods are 5½ ins. diameter, of special steel. The crosshead is of cast steel and slides in bored guides, which form the upper part of the frame of the engine. The crank shaft is a hollow steel forging, 20 in. diameter where the flywheel and generator are mounted upon it, and 18 ins. diameter by 36 ins. long, in each bearing of which there are two, one at each end of the crank shaft. The cranks are of the disc type overhung and pressed on to the shaft by hydraulic pressure, and the crank pins are of special steel 6½ ins. by 7 ins. in the bearings, also forced into position by hydraulic pressure. The flywheel is 19 ft. in diameter, and weighs about 34 tons, the weight being distributed as to 68 per cent. in the rim, 15 per cent. in the arms, and the remainder in the boss. The rim is in 10 segments, each cast along with one arm. When these are assembled the arms meet at the centre but do not touch. The boss consists of two flat discs, fixed one on each side of the arms and secured thereto by through-going fitted bolts, three in each arm. The governors are of the high-speed Porter type, there being two on each engine, one to control the cut off in both cylinders and one to actuate an emergency stop valve. The speed of the engine under normal working conditions is so controlled that it cannot vary more than 1½ to 2 per cent. from the normal.

The valve gear is of the well-known Reynold's corliss type with wrist plate motion, the trip gear being directly controlled by the governor. A special feature of this type of engine is the reheater-receiver fitted between the high and low pressure cylinders, and having tubes for heating the exhaust steam from the high pressure cylinder with high pressure steam, before admission to the low pressure cylinder, thus effectually drying the former and ensuring that the initial condensation in the low pressure cylinder will be very much reduced, and a corresponding saving effected in steam consumption.

OFFICIAL REPORT ON THE EFFICIENCY OF A 1000 KILO-WATT STEAM-TURBINE AND ALTERNATOR.

MANUFACTURED BY C. A. PARSONS & CO., Ltd., OF NEWCASTLE-ON-TYNE.

THE city of Elberfeld in Germany, having ordered for its electrical supply-works two steam turbines from the works of Messrs. C. A. Parsons & Co., at Newcastle-on-Tyne, entrusted an enquiry into their efficiency to Mr. W. H. Lindley, M.Inst.C.E., Herr M. Schröter, Professor of Mechanical Engineering at the Polytechnicum, Munich, and to Dr. H. F. W. F. Weber, Professor of Physics at the Polytechnicum, Zürich, from whose report on the results of the tests made by them we quote the following data.



1,000 KILO-WATT STEAM TURBINE AND ALTERNATOR, BY C. A. PARSONS AND CO., LTD., NEWCASTLE-ON-TYNE.

According to the specifications of the contract Messrs. C. A. Parsons & Co. undertook to make and deliver for the city of Elberfeld two steam turbines with alternators, exciters and condensers and air-pump plants complete. Each of these turbo-alternators, moreover, was to have an output of 1,000 kilo-watts useful effort at 4,000 volts, and with 50 complete cycles per second, made on an inductive load with cos. $\phi = 0.8$. The report states that not only have these conditions been completely fulfilled, but that the steam turbine yields a materially higher output, for, as determined by steam pressure in the steam chest, it showed that at 11 atmospheres it would amount to from 1,300 to 1,400 kilo-watts. The uniformity of the rotative forces acting in the turbine, the weight and great speed of the revolving mass, according to the report, justify the conclusion that the variation in speed of the rotation given by the periodical admission of steam does not exceed about of $\frac{1}{500}$ the mean actual speed of the machine, as was stipulated in the contract. The variation in the number of revolutions when the load is gradually changed from no load to full load, the steam pressure remaining constant, and *vice versâ*, amounted to only 3·6 per cent., *i.e.* 0·4 per cent. less than allowed in the agreement. According to the specifications the centrifugal governor was to maintain the number of revolutions constant to within 0·8 per cent. when the load is suddenly changed by 25 per cent. of the load at any time. During the tests it was shown that the governor regulated the speed with changes of load varying between 16 and 63 per cent. in such a way that the revolutions varied in round numbers from 1 per cent. to 1 9 per cent. immediately after the sudden change of load, whilst the permanent variation in speed amounted to from 0.4 per cent. to 1·3 per cent. The potential measured at the same time showed an average variation of 1·3 per cent. of the initial potential, when these sudden decreases and increases in the load were made. The electrical governor, during changes of load varying between 42 and 62 per cent. regulates the number of revolutions, and thereby the permanent potential, in such a manner that the average variation of the latter remained within 1·1 per cent. of the initial potential. This, according to the experts charged with the inquiry, not only fulfilled the stipulations but may be called excellent, especially when the rapidity with which the influence of the sudden decrease and increase in the load upon the number of revolutions of the steam turbine is overcome by the governing arrangement, is taken into consideration. It was stipulated that the drop of the potential of the turbo-alternator under constant speed between no load and full load, *i.e.* when developing zero, and when developing a thousand kilo-watts on a non-inductive load, shall not exceed 5 to 6 per cent. The tests showed that the drop of potential between no load and the normal load of 1,000 kilo-watts amounted only to 1·02 per cent., *i.e.* only 20 per cent. of the permissible drop, which must certainly be called a remarkable performance, and is pointed out as such in the report. The measurement, which was also made of the drops in potential with inductive load amounting to about 11 per cent. between no load and a load of 1,000 kilo-watts, is also a favourable feature. The actual steam consumption as compared with that guaranteed in the contract is shown in the table here following :—

Load in Kilo-watts.	Steam Consumption as guaranteed at 30° C. superheating.		Steam Consumption as measured at 14·3° C. average superheating.		Difference between guarantee and performance.	
	Per Kilo-watt Hour.	Of the Turbine in one Hour.	Per Kilo-watt Hour.	Of the Turbine in one Hour.	Kilo. per Hour.	Of the Turbine in one Hour.
(1)	(2) Kilos.	(3) Kilos.	(4) Kilos.	(5) Kilos.	(6) Kilos.	(7) Kilos.
1,250	—	—	8·63	10,786	—	—
1,000	11 0	11,000	9·19	9,189	− 1·81	− 1,811
750	11·3	8,475	9·99	7,496	− 1·31	− 979
500	12·0	6,000	11·41	5,707	− 0·59	− 293
250	14·0	3,500	15·28	3,821	+ 1·28	+ 321
No Load	—	1,060	—	1,840	—	+ 780

The tests were made at an average super heating of 14 degs. C. ; the steam consumption therefore will be, in reality, still somewhat less at the superheating of 50 degs. C., which is the figure stipulated in the contract.

A diagram in the report shows that the

curve of guaranteed steam consumption is intersected by that of the actual consumption as measured, at about 370 kilo-watts, and that consequently the consumption above that output is less than the guaranteed figure, while below it it is higher. In actual working the demand of the turbine will, of course, during the greater portion of the time be at the higher ranges of load, and only in exceptional cases will they be less than one-third of the normal load. The very much better results, therefore, that, as the tests have shown, are attained at the higher loads will far more than compensate the deficiencies at the lower loads and no load. The actual performance, therefore, as to steam consumption must, as the report says, be considered as being more favourable than the guarantee offered in the contract by a very great amount.

It was found impracticable to erect and test both turbines simultaneously, but as both turbines are, as regards construction, dimensions and proportions, exactly alike, it may be assumed with certainty that the results obtained with the second turbine will perfectly tally with those that were obtained with the one actually tested. In view of these results, obtained in Newcastle-on-Tyne, the three experts named in the beginning declare that, subject to the further tests to be made at Elberfeld, the conditions guaranteed by Messrs. C. A. Parsons & Co. in regard to the steam turbine, prior to its despatch from their works, have been complied with, which must be considered a deserved tribute to British engineering skill.

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WORKSHOP PRACTICE

The purport of this section of FEILDEN'S MAGAZINE is to give the skilled mechanic in our great industrial establishments an opportunity of bringing his practical ideas and experience into print. Inventive capacity and careful thought on the part of the workman is what we desire to encourage and foster. To this end we invite skilled mechanics, foremen, under-foremen, and heads of departments, to communicate practical suggestions, which, if accepted, will be suitably paid for. Wherever possible, drawings should accompany the contribution; rough sketches will suffice, as, when draughtsmanship is at fault, we will do all that is necessary to render them fit for publication. Nothing will be too poor for a careful inspection. Questions relating to shop practice are also invited, for which we pay one shilling. Answers to these questions that are printed are also suitably paid for according to merit.

❀ ❀ ❀

A Handy Shaping Attachment.—There are many attachments at present in use for shaping hexagon nuts, sockets, &c., but the one below described and illustrated may prove of interest as being very simple in design. It will be seen from the accompanying drawings that it is bolted to the shaping machine table in the ordinary way. It has a rectangular base-plate *a* about 1½ in. thick, with the front end, and also part of the back end, cast solid with it. The front end is bored out to receive the socket *B*, which in turn is bored out to receive the spindle *D*. This spindle is held in position by a small key sunk in the end, which slides into a key-bed provided for it in the socket, and can therefore easily be removed and replaced by one of larger or smaller diameter as circumstances may require. To remove this spindle, and also to get the work on and off same, pull pin marked C^1 out, when the back centre will swing back on the bottom pin seen in the drawing. The back head marked *C* is bored out to receive the barrel and centre, which are all one, and has a ⅜-in.-hole bored to receive a spring which is held forward by the cotter seen in the sketch, which passes through the barrel in a slot hole provided for the purpose. This allows for a backward and forward movement, which compensates for the radius described by the head, and always keep the back centre well up to its work. The division plate, marked *F*, is keyed fast on to socket *B*, and fits into a recess provided for it in front end of head. A plate fits on beyond this, and is secured by set screws in the usual way, which leaves the division plate and socket free to be revolved by the hand wheel. The division plate has 6 notches cut in the circumference, equidistant, which act as a guide for shaping hexagon nuts and sockets. To keep this plate from revolving when the machine is in motion a lug is cast on front end at *E*, which carries a lever held up to its work by a strong spring. This lever carries a die, which fits into the notches in division plate and holds it firm. To turn work round, press lever down by knob marked *K*, and turn hand wheel in the required direction, when spring will force lever up, and die will engage in notch in division plate and hold work firm. This operation can easily be performed without stopping the machine (a hole is drilled through underside of head to allow die on lever to pass through it to engage in division plate). The spindle *D* is screwed at back end, work is slotted on, and nut tightened up, when all is ready for action. (*Awarded* 10*s*.)

J. GREEN.

Setting out an Octagon Dome.—Sheet Metal Work presents many points of interest beyond its actual appearance, one in particular being the development of the surfaces. The illustration shows an example of an Octagonal Dome or finial as used in architectural design, formed out of sections of sheet-brass or copper soldered together and set out as follows:—Fig. 1 shows the elevation, Fig 2 the plan, Fig 3 the development. The line *A B*, Fig 1, is divided into any number of points, as 1, 2, 3, 4, &c., through these points let fall perpendiculars, cutting line *O P* at Fig. 2. On line *C D*, Fig 3, set off distance equal 1 to 10 + *E*, erect perpendiculars at these points, mark off heights of ordinates as 1, 2, 3, &c., from Fig. 2, then through these points of intersection trace the curve, which will represent the development. The pieces of metal are then bent upon a block of correct form, allowance being made for the thickness of the metal; previous to the bending the edges are filed to an angle of 22½ degs., thus making the included angle of 45 degs., as required for the octagon. (*Awarded* 5*s*.)

ALEX. STEWART.

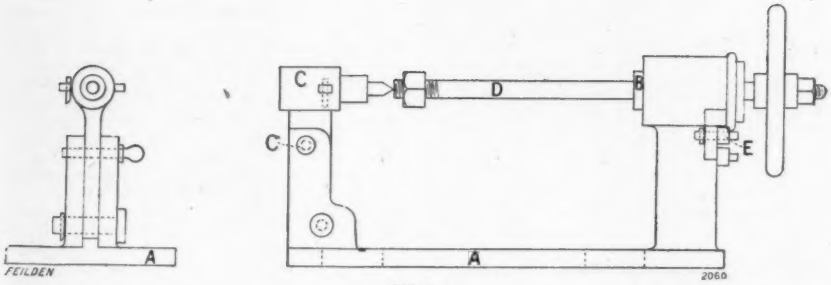


FIG. 1.

A HANDY SHAPING ATTACHMENT.

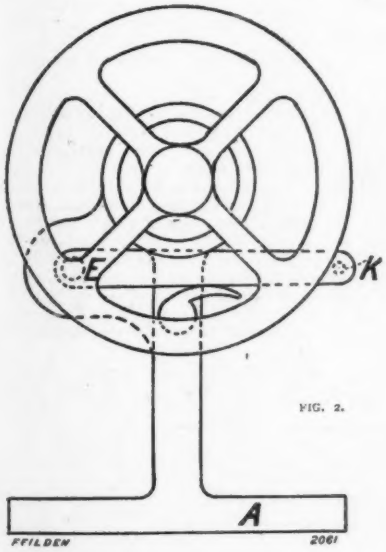


FIG. 2.

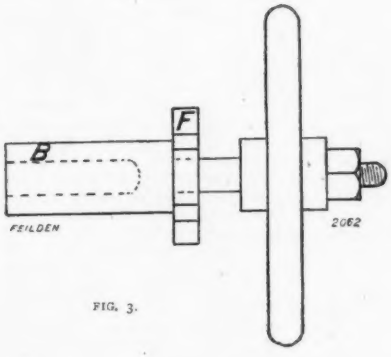


FIG. 3.

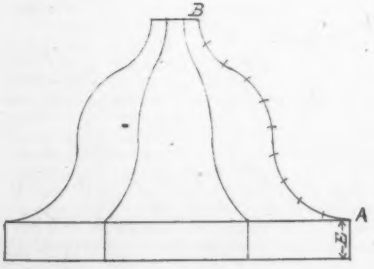


FIG. 1.—SETTING OUT AN OCTAGON DOME.

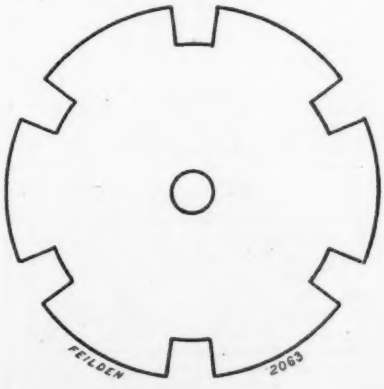


FIG 4.

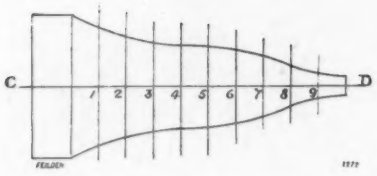


FIG. 3.—SETTING OUT AN OCTAGON DOME.

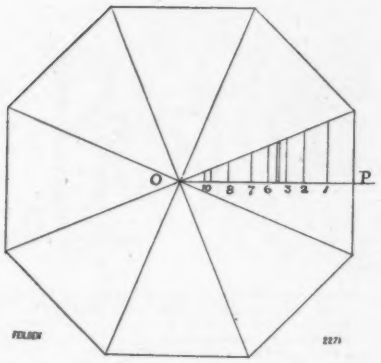
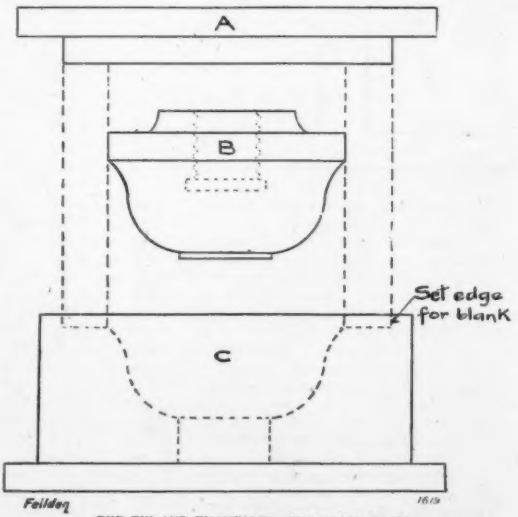


FIG. 2.—SETTING OUT AN OCTAGON DOME.

The Tin and Enamelled Holloware Trade.—A few words about this trade may not be without interest. Some years ago all the Holloware that was made was stamped either by foot, or later still by the steam stamp. It was a slow process, as the impression or force could only be carried down about 1 in. at a time, when a new force 1 in. deeper than the first had to be cast and put on. Where it became necessary to go to a depth of 5 ins. or 6 ins. this took a long time; besides which the constant blows on the surface of the metal hardened it to such an extent that in addition to its requiring to be put in the muffle several times to soften, it caused a lot of waste by the time the last force was reached. A change then set in, and one of the first firms in England to introduce the new power Drawing Press was the Anglo-American Tin Stamping Co. at Stourport. Their plant was brought from America complete, and erected at Stourport. Some great improvements have since then been made by two English firms, to wit, Messrs. Taylor & Challen, Engineers, of Birmingham. and Messrs. Rhodes & Sons, of Wakefield, Yorks, in the design and working of these presses. One of the greatest nuisances before that time was the constant attention required by the rollers, which had to stand all the pressure exerted by the press during the process of drawing down. They frequently required turning up in the lathe, as the quality of the work turned out depended on their being true. The frames of the presses also, being like all Yankee castings, were made very light, so that constant breakages took place. We have now the Toggle Power Drawing Press, that does away with rollers altogether, and the arms being vertical during the time of greatest pressure, nothing can give and all spring is obviated. These presses are made in all sizes from about 5 cwt. up to 60 tons. One of the latter was constructed by Messrs. Rhodes & Sons for Rio de Janeiro. The writer had charge of it out there, and it was capable of making up to 45-in. wash basins. The Portuguese and natives use basins for every purpose that they can, as they are light and handy. A great variety of dies and tools are used in these presses, some plain and simple in construction, others rather complicated in their working. As an illustration we will take a plain set of basin dies, they consist of three main parts, viz., one blank-holder *A*, one force or punch *B*, and one bottom die *C*. By referring to the drawing this will be better understood. In a drawing press there is a double action, one carries the blank-holder, and the other the punch. A blank is cut in the circular cutters to fit the set edge in the bottom die. It is then placed in



THE TIN AND ENAMELLED HOLLOWARE TRADE.

position, and the blank holder comes down and grips the circumference of the blank. The punch then descends and presses the blank into the shape of the bottom die. They are, as a rule, drawn two or three at a time, as less waste is caused by doing this. The difference will be seen between this and the old method, as we are now drawing these at one operation 3¼-in. deep. They have now to be shaped, and all wrinkles either spun out on the spinning lathe or given a few blows under the steam stamp. They then require to be trimmed and beaded, which is done on the lathe, after which they are ready for re-tinning or enamelling. Under the stamp two or three gross would be a day's work for one man. With the power-drawing press a girl will turn out forty to fifty gross in the same time. (*Awarded 7s. 6d.*)

EADES.

shaft to the centre of the rope and the weight (*W* in sketch). Start the engine now, and after it is running fairly steady note the number of revolutions per minute by the speed indicator and the pull indicated by the spring balance.

$$\text{The b.h.p. now} = \frac{2\pi R n P}{33000}$$

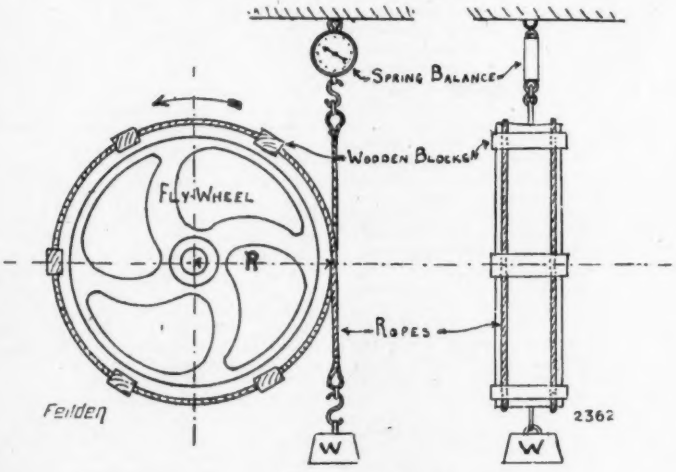
$$\text{or since } \frac{2\pi}{33000} \text{ is a constant,}$$

$$\text{the b.h.p.} = \cdot 0001904 \times R \times n \times P.$$

Where P = difference between the load W and the pull indicated by the spring balance.
n = number of revolutions per minute.
R = radius in feet from the centre of the shaft to the centre of the rope to which the load W is attached.

(*Awarded 7s. 6d.*). J. T.

[The most reliable tests are those made *without* any lubricants, and in the best practice their use is condemned. Some provision must be made for cooling the fly-wheel by a jet of water flowing on the inside of the rim.—ED.]



METHOD OF TESTING OIL ENGINES.

A Method of Testing Oil Engines or Gas Engines.—The following is one of the simplest and most easily applied ways of finding the brake horse-power of an engine. The brake horse-power—or b.h.p., as it is usually written—is the power given out by an engine, independent of the power absorbed in friction—that is, in driving the engine itself. This method has the following advantages: (1) It can be made quickly from materials which can be had in any workshop; (2) it is easily adjusted; (3) it is very inexpensive; (4) if the load is properly adjusted before starting the trial, the readings on the spring balance will be very steady. The sketch explains itself, and shows the materials required and the method of fixing them to the fly-wheel. The rim of the wheel should be kept well lubricated with paraffin. Ascertain the radius (R in sketch) in feet from the centre of the

Under this section will appear in the March issue a practical article on the Construction of Cycle Chains, an industry which has become representatively British. It will be a particularly valuable article, more especially as it deals with the conditions regulating rapid and remunerative production. Another important communication will deal with the "Construction of Gas Engines," in which will be presented practical points which ought to be kept well under notice in the design, construction and erection of an engine.

INDUSTRIAL PROGRESS

ENGINEERING NOTES AND COMMERCIAL INFORMATION

FROM ALL SOURCES.

CIVIL ENGINEERING.

Bridge Building.—In a paper on the "Development and Present Status of Bridge Building," Mr. J. M. Moncrieff, the designer of the Redheugh Bridge at Newcastle-on-Tyne, gave to the Students' Association of the Institution of Civil Engineers at Newcastle a very interesting outline of the history of bridge building and of its future prospects. Speaking of the use of iron and steel as building material, he pointed out to his audience the High Level Bridge as one of the finest specimens of cast-iron work to be found anywhere. He remarked that instead of following the lines of tubular bridges, the development had been rather on the basis of the principles laid down by Brunel. Since the middle of the century just concluded, there had been a great improvement in the materials used for bridge construction. The great progress made in the manufacturing of mild steel had led to the abandonment of wrought-iron, and the former is considered as much superior to the latter as the latter is superior to cast-iron. There is good reason to hope that still further improvements in the material for bridge building will take place, and that the danger of corrosion will be (if not entirely eliminated) at least reduced to a minimum. Nickel-steel may be found to answer the purpose, but it will need to be tested in less important structures ere it can be tried in bridge building. In conclusion he remarked that the superiority of American bridge building, to some extent at least, is due to specialisation, and that the craft should become a separate branch of civil engineering, as it was quite comprehensive enough to deserve such specialisation.

New Suspension Bridge. — Mr. G. H. Gadsby, Westminster, and M. Arnodin, a French engineer, will be entrusted, it is said, with the execution of a scheme for bridging the Tyne at the harbour mouth between North and South Shields. The promoters of the enterprise are a syndicate formed for the purpose, with a capital of £130,000. The structure will be a suspension bridge, of a sufficient height above the river to allow shipping to proceed without interruption, and the altitude decided upon is 200 ft., the bridge having a clear span of 640 ft. M. Arnodin is at present engaged in erecting a similar bridge at Newport, Mon., *i.e.* a platform suspended by cables sufficiently large to accommodate tramcars, horses, carts and passengers.

IRON AND STEEL.

Economy of Pneumatic Drilling and Riveting.—The enormous difference in cost between riveting and drilling by hand and by means of pneumatic tools is clearly evidenced by the report, recently issued, of a committee appointed by the American Association of Railway Superintendents of Bridges and Buildings to inquire into the use of pneumatic tools in the field for riveting and repairing. During the erection of 2,455 lineal feet of bridge-work, two men and a heater working a pneumatic riveter averaged 500 rivets per day, while three men and a heater working by hand, working steadily, could accomplish no more than 250 rivets daily. On a special occasion, when a third man accompanied the pneumatic riveting gang, in order to take out and fit up bolts, 700 rivets were driven during the day, and, what is more, during inspection it was seen that the work done by the machine was far superior to that done by hand. The pneumatic tool used was a portable compressor driven by a gasolene engine. As regards expense, it was found that the cost of operating hammer per day, including power, repair, and depreciation, was £1 13*s.* 10*d.*, or 6*s.* 9*d.* per hundred rivets, ⅞ in. in diameter; while with hand riveting the cost was 15*s.* 4*d.* per hundred. In another case the committee found that the cost of fitting up and riveting new steel bridges had been reduced 40 per cent. by using mechanical in place of manual labour. It was also found that by using a pneumatic drill instead of a ratchet drill from five to six times as many holes can be pierced per day. Even allowing for some deduction on account of the extra efficiency, resulting from the desire to establish a record for the tool, which makes men work with more than their usual energy, the figures given are so striking as to leave no doubt that hand-labour cannot possibly hold its own against work by pneumatic tools.

ELECTRICAL ENGINEERING.

A Noteworthy Power Transmission Plant.—The following are the main features of a power plant recently constructed by Messrs. Ernest Scott & Mountain, Ltd., for the Broughton & Plas Power and Coal Co., Ltd., near Wrexham, which undoubtedly deserves notice. It consists of two horizontal compound engines, each developing

350 h.p.; two 200-unit four-pole generators driving by ropes; a main switchboard with the usual measuring instruments; two 150-h.p. electric motors for driving haulage gear; an endless rope haulage gear for operating three roads; one 60-h.p. motor for pump-driving; one three-throw pump to deliver 150 gallons per minute to a height of 800 ft.; one electrically-driven pump to deliver 50 gallons per minute to a height of 125 ft.; and one 5-h.p. motor driving single-barrel pump through worm-gear. The engines are fitted with automatic triple-expansion gear, and each of them is provided with a rope fly-wheel 14 ft. in diameter, grooved for ten ropes of 1¼ in. diameter. The dynamos of the Scott & Mountain's four-pole type have an output of 200,000 watts, 400 amperes at 500 volts, and are revolving at the rate of 450 revolutions per minute. Each of them is provided with three bearings of the self-oiling, self-aligning type, and a rope pulley of 31 in. diameter, grooved to the same template as the fly-wheel of the engines. In order to permit the taking up of the slack of the ropes while the machines are running, the dynamos are fitted on cast-iron sliding bedplates with tightening screws and brackets. The three-drum endless rope haulage is driven by one of the 150-b.h.p. motors fixed at a point 1,130 yards from the shaft bottom. This haulage is of a specially heavy kind, the rope wheels being 6 ft. 6 in. in diameter and each of them being fitted with Hall's type of friction clutch and automatic brake, both clutch and brake being operated by hand-wheel from the driving platform. The driving pulley is 8 ft. in diameter, grooved for nine ropes of 1¼ in. in diameter. The total length of rope operated aggregates 4,470 yards, and the haulage is so constructed as to deliver 650 tons to the pit bottom per shift of eight hours. The second of the 150-h.p. motors is driving existing haulage gear through ropes, and is placed near the shaft bottom. The large pump is of Scott & Mountain's special mining type with three rams, each 6 in. in diameter, by 12 in. stroke, and capable, as above stated, of delivering 150 gallons per minute against a head of 800 ft.; the small three-throw pump is of Scott & Mountain's ordinary mining type with three barrels, each 4 in. in diameter by 6 in. stroke.

TEXTILE INDUSTRIES.

Textile Markets. — H. M. S. Agent in Abyssinia, Mr. J. L. Baird, in his recent report to the Foreign Office on the trade of Adis Abbaba and Narrar, points out that the orderly Government of the country under the Emperor Menelik has inspired an amount of confidence, both among natives and foreigners, formerly unknown in Abyssinia, and the people feel no hesitation in investing their money for the acquisition of articles of comfort and even of luxury. Under these circumstances, the chances for lucrative trade are increasing, and Mr. Baird thinks that there would be a good demand for European made burnouses, if they could be supplied of a slightly superior quality and at the same price as the locally made article. At present the market for cotton sheeting is monopolised by Americans, who furnish a material distinguished by strength, durability, and good washing qualities; but there seems to be no reason why British manufacturers should not be able to offer successful competition. Fancy silks also, it is asserted, would find a ready sale.

MISCELLANEOUS.

Anti-Friction Alloys. — Of all the anti-friction metals in the market the genuine Atlas Metal, "W. E. Watson's Brand," appears to be leading, and has found its way to practically all parts of the civilised world. This fact in itself speaks eloquently for its efficiency, and it is supplemented by the testimonials of engineers of the highest standing, who unreservedly express the opinion that bearings of atlas metal have an astonishing longevity out-lasting two or three times the bearings of other metals, so that the makers have not much to fear from competitors.

Sewage Disposal.—The Royal Commission on Sewage Disposal recently visited the Reigate Corporation Sewage Works at Redhill, in order to inspect the Candy-Caink Revolving Sprinkler System and Polarite Oxidation Bacterial Bed, which has been in use for over two years and given complete satisfaction. Sir Michael Foster, M.P., F.R.S., Major-General Phipps Carey, Col. Harding and Mr. J. J. Willis, the visiting members of the Commission, were met by the Mayor, the Borough Engineer, and several other gentlemen; and entered upon a careful investigation of the system above named, which mainly consists in feeding the Polarite Oxidizing Aerobic Bed in an intermittently continuous manner by means of the Candy-Caink Revolving Sprinkler. It is stated that with about half an hour's treatment a very strong sewage, containing tannery and brewery refuse, can be converted into a bright, odourless and oxygenated effluent. After the inspection the members of the Royal Commission adjourned to the Town Hall to take the evidence of Mr. Frank Candy, General Manager of the International Purification Syndicate, of 109, Victoria Street, Westminster, on the subject, and also of the Borough Engineer, Mr. W. H. Prescott, who explained the working of the system, tendering analytical results which showed an average purification of 97 per cent.

Acetylene.—The use of acetylene on the Continent is steadily increasing, and the scientific study of its properties is carried on with such vigour as to justify the assumption that in the very near future it will take a secure place in the front rank of modern illuminants. There is no reason to doubt that Great Britain will rapidly follow suit, for our industrial circles appear to have learned the lesson that it will not do in this age of rapid progress to be left behind in the race, as we have been left behind in the use of electricity; for where so many are competing the front line is quickly

filled up, and stragglers have hard work when trying to push themselves in again once that they have lost their place. We are glad to learn that thirteen of the leading gentlemen in the acetylene industry have given both their moral and their financial support to the organisation of a society to be known as the "Acetylene Association," and will be represented in a council of 18 which is to undertake the management. Mr. Worth has accepted the office of chairman, and Mr. J. R. Fawkner that of secretary. The *Journal of Acetylene* is to be the official organ of the association.

A Successful Commercial Intelligence Bureau.—The work of the well-known Intelligence Bureau in Queen Victoria Street, London, had been so much increasing of late that new business premises became necessary, and its headquarters are at present at 49 and 51, Eastcheap, London, where they occupy 4,000 sq. ft. on the ground floor. The Cabinet of Trade Digest, for each separate trade, is claimed to be the most complete in existence anywhere, each cabinet containing from 5,000 to 10,000 entries, new entries being made constantly, and being supplied by post to subscribers. The subscription for the complete service amounts to £6 per annum.

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In this section is presented every month a concise précis of the contents of the leading organs of the technical press and of the proceedings of the learned societies throughout Great Britain, the Continent, and America, and also, in a summarised form, the subject matter of the more important articles appearing therein.

This systematic record should prove of the greatest value to those of our readers interested in one or more specific sections of technology, trade or economics, or to those who have insufficient leisure to peruse the large number of publications now appearing.

In most cases where publications are not readily procurable, with the exception of Transactions of the Learned Societies, copies of the articles can be supplied on application by remitting 7d. Should any of our readers desire further information we shall be happy to supply it.

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ARCHITECTURE AND BUILDING.

1. Construction and Design.

Flooring.—*The Bromley Fireproof Floor.* Description of a fireproof floor in which vaulted portions of burnt plaster are the chief constituents.—*Engineering Record*, Nov. 3rd, 1900, p. 426. (Ill.)

Iron Structures.—*Some Iron Structures at the Paris Exhibition.* By F. Frahm. Technical description, accompanied by illustrations and sketches reproduced from *Engineering* and *Génie Civil.* The present instalment deals with the Monumental Gate. (To be continued.)—*Stahl u. Eisen*, Nov. 15th, 1900, pp. 1158-65.

Roofing.—*The Roofing of Farm Buildings.* By A. T. Walmsley, M.Inst.C.E. Abstract of a paper read before the Surveyors' Institution, on Nov. 26th, 1900, in which the author, without pretending to have arrived at any definite conclusions as far as the arrangement of farm buildings is concerned touches upon a few important points as regards details of structures.—*Builders' Journal*, Dec. 5th, 1900, pp. 349-52. (Ill.)

Roof Truss.—*Roof Truss Details.* Description of a roof truss of a dynamo room, designed by Mr. J. E. Dretrick, of Omaha. The truss is proportioned to allow the hoisting of loads not exceeding three tons at any of the intersections of the lower chord. When loaded in this way, some of the members usually in tension will be in compression, and *vice-versâ*.—*Engineering Record*, Oct. 27th, 1900, p. 392. (Ill.)

2. Heating and Ventilation.

Lighting, Heating, Ventilating, etc.—*The Mechanical Plant of a Large Apartment House.* This is a description of the complete heating, lighting and ventilating outfit, together with the apparatus for the lifts, refrigerating and steam-raising machinery, in a New York family hotel of the better class, having a height of 13 storeys.—*Engineering Record*, Oct. 27th, 1900, pp. 400-403. (Ill.)

3. Plumbing and Gasfitting.

4. Miscellaneous.

Gothic Architecture.—*The Revival of Gothic Architecture.* Abstract of a paper by Halsey Ricardo, read before the Liverpool Architectural Society, Nov. 5th, 1900.—*Builders' Journal*, Nov. 14th, pp. 290-93.

Gothic Architecture.—*The Revival of Gothic Architecture.* Abstract of a paper read before the Liverpool Architectural Society by Halsey Ricardo. Very interesting article, showing the spontaneity of earlier European architecture, of its artificiality in later times, and of its revival.—*British Architect*, Nov. 9th, 1900, pp. 336-39.

CIVIL ENGINEERING.

1. Bridges.

Bridges.—*A New Bridge over the Thames at Lambeth.* In consequence of the unsatisfactory condition of Lambeth Bridge, the Bridge Committee of the London County Council instructed Sir Alexander Binnie to prepare a design for a bridge capable of meeting the requirements of the traffic. In consequence, two designs were presented, one for a suspension bridge and one for a braced arch type, of both of which the article gives a short outline.—*Engineer*, Oct. 26th, p. 414.

—— *Laboratory Work in the "Bau-Ingenieurschule," with special reference to the Construction of Models.* By Steiner. The article deals with the instruction given to students in the department for bridge-building at the Technical High School at Prague, by the author, who presides over the laboratory, where he supervises the construction of models from designs, and dwells on the great value of such laboratory work.—*Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereins*, Nov. 16th, 1900, pp. 709-12. (Ill.)

Steel Railway Bridges.—*Proposed Specifications for Steel Railway Bridges.* Abstract of a paper read at a meeting of the Western Society of Engineers, in which the author dwells on the alterations caused in the material used for iron bridges by the vibrating masses of locomotives, in consequence of great speed and faulty track, and calculates the structural data for building railway bridges with reference to these phenomena.—*Engineering News*, Oct. 11th, 1900, pp. 255, 256. (Ill.)

2. Canals, Rivers and Harbours.

Canals.—*Central American Ship Canals.* The article deals with resumption of the Panama Canal construction works in rather a hopeful way, and contains a detailed description of the work contemplated and of improvements in method, indicating that experience has not been entirely unprofitable.—*Engineering*, Nov. 9th, 1900, p. 455.

Dams.—*Modern Dams and Ancient Waterworks.* Abstract of an address by Mr. James Mansergh, the newly elected President, read before the Inst. of Civil Engineers, and dealing with the development of water purification up to the present time; the portion here reproduced comprises the author's remarks about the coming into fashion of a stone dam, and alluding to the hydraulic engineering of the ancient Egyptians (including a dam of hewn stone at Kosheish, to divert the course of the Nile, nearly 5,800 years ago), the work of the Persians, the Greeks, the Romans.—*Builder*, Nov. 10th, 1900, pp. 415-17.

3. Irrigation.

4. Miscellaneous.

Road Building.—*Oiled Roads and Their Benefit.* Abstract of a paper by Mr. White, read at the meeting of the Good Roads Association of Southern California, in which the author points out the advantages of using oil instead of water for sprinkling dusty roads.—*Engineering Record*, Nov. 17th, 1900, pp. 440, 241.

Road-Making.—*Roads.* Digest of a treatise by Thomas Aitken, A.M., A.M.Inst.C.E., divided into two parts, the first relating to the making of macadamised roads, while the second part deals with carriage-ways and footpaths.—*Builder*, Dec. 1st, 1900, pp. 477-79.

ELECTRICAL ENGINEERING.

1. Electro-Chemistry.

Electric Furnaces.—*An Electrical Platinum Furnace.* Prof. Nernst's description of a small platinum furnace constructed from his designs by Messrs. Mohr & Loehrs, in Rudolstadt, for the purpose of studying the conductivity of mixtures of metal-oxides at a high temperature. In these little furnaces a temperature of 1,400 degs. can be obtained and maintained, and a current of 110 volts requires only 2·4 amps. Their price is about £2.—*Zeitschrift für Elektrochemie*, Nov. 8th, p. 253. (Ill.)

Electro-Chemistry.—*The International Congress of Applied Chemistry in Paris.* Short digest of the various papers, with an introduction of a rather pessimistic nature, in which the comparative lull in the rapid progress of the new science is interpreted as almost a sign of collapse.—*Electrical Review* (London), Oct. 19th, 1900, pp. 616, 617. (To be continued.)

Electrolysis.—*The Commercial Electrolysis of Water.* Digest of an interesting paper on the subject by M. Buffa, describing methods for obtaining the decomposition on a commercial scale. As an example the author describes an installation at Rome, where 0·086 cubic mètres of hydrogen are obtained per horse-power, and a factory in Brussels which produces 0·12 cubic mètres for the same expenditure of energy; at Rome, where the kilo-watt years cost 96·62 frs., the cost of 1 cubic metre of hydrogen and ½ cubic metre of oxygen amounts to 20c.—*Electrician*, Nov. 2nd, pp. 46, 47.

—— *Electrolytic Separation of Iron and Nickel from Solutions of their Sulphates.* By Prof. Dr. F. W. Küster, of Klunsthal. Paper read at the general meeting of the German Electro-chemical Society at Zürich, Aug. 6th to 8th, 1900.—*Zeitschrift für Elektrochemie*, Nov. 8th, pp. 257-59.

—— *Velocity of Reaction during Electrolytic Reductions.* By Prof. D. Goldschmidt, of Heidelberg. The author treats this subject in a paper read before the General Meeting of the German Electro-chemical Society at Zürich, and describes a method for ascertaining the velocity, based upon measuring the maximum strength of current before the appearance of free hydrogen at the cathode.—*Zeitschrift für Elektrochemie*, Nov. 8th, 1900, pp. 263-68.

—— *The Electrolytical Regeneration of Chromic Acid and the Manufacture of Acid-proof Diaphragms.* By Prof. Dr. M. le Blanc. Full reprint of a paper read by the author at the General Meeting of the German Electro-chemical Society at Zürich, Aug. 6th to 8th, 1900.—*Zeitschrift für Elektrochemie*, Nov. 8th, 1900, pp. 290-95.

Electrolysis.—*Electrolysis of Water on a Large Scale.* This is a paper by Prof. Dr. O. Schmidt, of Zürich, read before the General Meeting of the German Electro-chemical Society at Zürich, in which the author describes an economical method for the decomposition of water, and draws attention to various uses of hydrogen, which permit us to hope that in the near future the production of hydrogen will pay, especially as oxygen will be obtained as a by-product.—*Zeitschrift für Elektrochemie*, Nov. 8th, pp. 295[illegible].

2. Electric Lighting.

Electric Light.—*The Alternating Current Arc. I.* By Wiler. General characteristics of the alternating current arc, connection between length of arc, tension, and current, resistance of alternating current arc; quality of carbon to be used, etc.—*Electric World*, Nov. 22nd, 1900, pp. 977-79. (Ill.)

Electric Lighting.—*The New Storage Battery of the Kansas City Electric Light Company.* Description of a large battery for feeding a three-wire system of from 2 to 110 volts; the battery is charged by two continuous current transformers, with a primary current of 500 volts. *Electric World*, Nov. 3rd, 1900, pp. 686-88. (Ill.)

3. Power.

Dynamos.—*Combined Engine and Dynamo.* Description of a unit consisting of a horizontal engine, with peculiar piston-valve device, of 400 h.p., coupled with a continuous current dynamo of 220 kilo-watts at from 220 to 235 volts.—*Engineer*, Nov. 9th, 1900, pp. 472-74. (Ill.)

—— *Adjusting Reluctance of Magnetic Circuit.* A rotating body consisting of iron sheets is placed in the field of the lines of force of dynamo. If this body is so turned that the lines of force are traversing the iron sheets and isolating paper sheets, the magnetic resistance of the field of the lines of force is greater than in a position in which the lines of force are parallel to the plane of the iron sheets. The device is used in connection with multipolar dynamos in order to adjust the differences between the electro-motive force at each pair of brushes.—*Electric World*, Oct. 27th, 1900, pp. 646, 647. (Ill.)

Electric Power Units.—*Electric Generators of the Cail and Thomson-Houston Type.* Description of an engine developing at a pressure of 12 atmospheres from 1,300 to 3,100 i.h.p. (according to load), coupled with an alternator of 75 revolutions per minute, constructed for a normal work of 1,000 kilo-watts.—*Génie Civil*, Nov. 10th, 1900, pp. 21-23. (Ill.)

Motors.—*The Induction Motor. II.* By Behrend. Calculation of electro-motive force and of the ampère windings; formulas for finding periodicity, efficiency, intensity of field, etc.—*Electric World*, Nov. 10th, 1900, pp. 725, 726. (Ill.)

—— *The Induction Motor. I.* By Behrend. The author fully discusses the theory of the asynchronous motor, mainly on the basis of the works published by authorities on the subject, including the general theory of alternating current transformers; the displacement of phases, the factor of efficiency, etc.—*Electric World*, Oct. 27th, pp. 676-78. (Ill.)

Power Plant.—*Electrical Plant at the Sneyd Colliery.* Description of a plant comprising the most modern electrical machinery at the above-named colliery at Burslem, Staffordshire, designed by and constructed in accordance with the specifications of Dr. J. A. Fleming.—*Electrical Review* (London), Nov. 9th, pp. 749-51. (Ill.)

—— *The New Municipal Power Stations in Liverpool.* The article deals with two new stations, the building of which was undertaken in 1898, and which are now completed; each of them being divided into four independent sections, consistin gof seven boilers with economiser and three steam-dynamos, and accessories.—*Electrician*, Oct. 19th, pp. 953-55. (Ill.)

Power Plant.—*Electric Power at the Patent Shaft and Axletree Company's Works.* Description of a three-phase power installation at the above-named works, which employ 3,000 men, and cover an area of 500 acres. The power station, which is built with a view to future enlargement, contains two vertical compound engines of 210 h.p. each, with 375 revolutions per minute, cylinder diameter of 16 in. and 24 in., and 12 in. stroke, direct coupled with generators of the Brown-Boveri three-phase type, of a periodicity of 50 and a voltage across the phases of 350. Within the near future a unit of 500 h.p. is to be added. The article also describes the switch-board and motors.—*Engineering*, Nov. 2nd, pp. 563-65. (Ill.)

—— *Alternating Current Plants.* The author discusses the methods for constructing alternating current plants customary in the United States, and illustrates by practical problems the conditions determining the choice of method, and the best way of calculating the required data.—*Elektrotechnische Zeitschrift*, Oct. 18th, 1900, pp. 858-61. (Ill.)

—— *An Electrical Lead Mining Plant.* Description of a plant in which electric power is used for mills, pumps, ore separators, and for a short railway connecting three mines; the power plant consists of four Babcock & Wilcox boilers, one horizontal Corliss engine of 850 h.p., and another similar one of 530 h.p., both coupled with continuous current motors of 250 kilo-watts at 500 volts.—*Electric World*, Nov. 10th, 1900, pp. 723, 24. (Ill.)

—— *The Electric Power Stations of the Liverpool Corporation.* Description of the two new stations recently completed.—*Electrical Review*, Oct. 19th, 1900, pp. 625-27. (Ill.)

—— *Guernsey Electricity Work.* Description of the works recently established by Messrs. Edmundson's Electricity Corporation in the island; the generating sets are two in number, consisting of an E. C. 5 Belliss engine, rated at 100 b.h.p., with 130 lbs. pressure, and running at 500 revolutions per minute, coupled direct to a Parker dynamo, giving 74 kilo-watts, or 160 ampères at 410-460 volts.—*Electrical Review* (London), Oct. 19th, pp. 627, 28. (Ill.)

Power Plant Systems. — *Sheffield Corporation Electric Supply Department.* Report by Mr. S. E. Fedden, chief engineer of the Sheffield Electric Supply Department, who visited France and Germany in order to gain information with regard to Continental practice in single-phase and polyphase alternating systems.—*Electrical Engineer*, Nov. 16th, 1900, pp. 709-12.

Power Transmission.—*The St. Lawrence Power Company; Plant at Massena, N.Y.* Description of one of the largest power transmission plants in existence, which is now nearing completion, at the little town of Massena, N.Y., near the St. Lawrence River, and is being constructed with the ultimate aim of transmitting 150,000 h.p., but for the immediate future the canal dug has a capacity of 75,000 000.—*Scientific American*, Nov. 17th, 1900, p. 310.

4. Telegraphy and Telephony.

Telegraphy.—*The Telautograph.* Description of the invention and the principles on which it is based, accompanied by a specimen of an original and a transmitted message, plainly showing the almost complete identity of appearance.—*Electrical Review* (London), Nov. 19th, 1900, pp. 771, 72.

—— *The Telautograph.* This is a detailed description of Mr. Foster Ritchie's invention, for which the patent rights are now fully secured, comprising apparatus for transmitting autograph messages, diagrams, sketches, etc., and representing, as our contemporary justly remarks, "a wonderful combination of electrical knowledge and mechanical skill."—*Electrical Engineer*, Nov. 16th, 1900, pp. 698, 99. (Ill.)

—— *The Present State of Wireless Telegraphy.* By Prof. A. Blondel and Capt. G. Ferrie. The authors deal with the subject, taking the term "wireless" in the sense of telegraphing by what is called "Hertzian" waves, and, after a short historical summary, give an outline of the theory and the gradual improvement made in the practical application up to the present time.—*Electrician* (London), pp. 21, 22.

Telegraphy. — *The Pollak-Virelg Telegraph. Further Developments.* By Chas. H. Garland. The author describes some interesting developments of the invention since March of the present year, including a device by which 1,000 words per minute can be telegraphed in ordinary characters. — *Electrical Review* (London), Oct. 19th, 1900, pp. 628-33, and Oct. 26th, pp. 651, 652. (Ill. To be continued.)

5. Miscellaneous.

Alternating Current Apparatus.—*The Course of the Interruption Spark in an Alternating Current Circuit with Metal Electrodes.* By Ludwig Kallir, Engineer. There is a difference in the behaviour of a spark which appears at the terminus of metallic electrodes, according to whether alternating or continuous current is used. The author gives the result of experiments made with the object of studying this difference.—*Elektro Techniker*, Nov. 30th, pp. 316, 317.

Electric Smelting Furnace.—*The Hatch Electric Smelting Furnace.* Description of a furnace consisting of a rotatory cylinder, the inner surface of which is a seven-sided prism, each side consisting of 10 parallel rods of graphite, and which, by a special device, are so arranged as to be cut out of the circuit during a portion of the revolution, thus preventing the current from passing through the ore to be melted. The efficiency of the furnace is such that three tons of ore can be molten within from two to three hours by a current of 600 amps. at a tension of 10 volts.—*Electric World*, Oct. 6th, 1900, pp. 543-544. (Ill.)

High Tension Currents.—*Review of the Development of High Tension Current Engineering during the last three years.* An interesting review of the various problems connected with high tension currents and their more or less successful solution by various inventors.—*Dingler's Polytechnisches Journal*, Nov. 10th, 1900, pp. 709-14. (To be concluded.)

—— *A Review of the Development of High Tension Current Engineering during the last three years.* (Conclusion.) This instalment deals with improvements in measuring devices, electric lighting, the Nernst lamp, transmission of force, the limits of high tension currents in alternating plants, the use of electricity as motive power in narrow-gauge and normal gauge railways, electric auto-motors, etc. — *Dingler's Polytechnisches Journal*, Nov. 17th, 1900, pp. 732-37.

MARINE ENGINEERING AND SHIPBUILDING.

1. Merchant Vessels.

Steamships. — *Atlantic Steamships—Present and Future.* The author analyses the chief features of the great Atlantic liners of the present day, notably the *Ivernia* and the *Deutschland*, and concludes that if a 30-knot Transatlantic steamer makes its appearance within the next few years, it is safe to say that it will be driven by the combination of water-tube boilers, using hot, forced draught, with fast-running reciprocating engines, using super-heated steam, or with turbines of the Parsons type; and that so great will be the reduction of weight and the saving of space achieved by this change, that it will be quite within the possibilities to produce, on a displacement not greater than that of the *Deutschland*, a 30-knot ocean steamer that shall have equal accommodation for passengers.—*Scientific American*, Nov. 10th, 1900, pp. 289 and 294.

Steamers.—*The Steaming Radius and the most Economical Speed of Steam Vessels.* Description of experiments made on board the auxiliary cruiser *Yosemite*, of the United States Navy, during the war with Spain, the object being to ascertain the greatest steaming radius. —*Engineering News*, Oct. 18th, 1900, p. 263. (Ill.)

Torpedo Boats.—*The Torpedo Boat "Viper" in Dry Dock.* The article, accompanied by a photographic reproduction, gives a short description of the remarkable little craft whose popularity rests on its sensational speed,

which, according to official records, represents a mean of 36·78 and a maximum of 37·1 knots an hour.—*Scientific American*, Nov. 24th, 1900, p. 228.

2. Pleasure Craft.

Yachts.—*S. Y. "Arrow," designed to steam at the rate of 40 knots.* Description of a twin-screw steam yacht designed by Naval Architect Charles D. Mosher, of New York, for Charles R. Flint, of New York, with the aim of excelling in speed all existing vessels. Its dimensions are; Length extreme, 130 ft.; beam extreme, 12 ft. 6 ins.; displacement, at normal draught of 3 ft. 6 ins., 6,766 tons. The engines are to be of the Mosher patent quadruple expansion type.—*Marine Engineering*, Nov., 1900, pp. 448-55. (Ill.)

3. Equipment and Machinery.

Marine Engines.—*The Steam Turbine in Large Merchant Steamers.* By Rear-Admiral George W. Melville, Engineer-in-Chief, U.S. Navy. The author in his interesting article gives his reasons for disbelieving that the turbine is to-day in a position to replace the reciprocating engine; and further, that unless it shows greater economy than it has heretofore shown, it cannot replace the reciprocating engine on shore.—*Scientific American*, Nov. 24th, p. 323. (Ill.)

—— *Six-Cylinder Triple Expansion Engines of Chilian Corvette "General Baquedano."* By Magnus Sandison. Abstract of a paper read before the Institution of Naval Architects, London, in which the author, a member of the firm of Hawthorn, Leslie & Co., Ltd., who built the machinery, describes the engines, the design of which contains some novel features.—*Marine Engineering*, Nov., 1900, pp. 455-60. (Ill.)

Ship-building Tools.—*Arrol's Machine Tools in Ship-building Works.* Description of various large machine tools manufactured at the Dalmanrock Iron Works of Sir William Arrol & Co., in the East End of Glasgow, including a hydraulic forging press, a hydraulic joggling press for the shell-plates of ships, a vertical hydraulic angle iron shears for cutting bars into short lengths, a pipe-flanging press, and a hydraulic tube-staving press.—*Marine Engineer*, Nov. 1st, p. 324.

4. Docks.

5. Miscellaneous.

Ship-building.—*Progress in Modern Steel Ship and Engine Building in Japan.* Description of the principal ship-yard at Nagasaki, known as the Mitsu Bishi Dock-yard and Engine Works, and controlled by the Mitsu Bishi Company at Tokio; and a short account of the work so far accomplished there.—*Marine Engineering*, Nov., 1900, pp. 473-76. (Ill.)

Ship-yard Accessories.—*Ship-yard Tools by Bertram's, Limited, Edinburgh.* Description of a number of improved tools, including a double-ended punching and shearing machine, a cam-lever punching and shearing machine, a set of plate-bending rolls, a beam and angle-iron bending and straightening machine, a plate-straightening machine, a circular cutting machine, and a specially designed elliptical lathe.—*Steamship*, Nov., 1900, pp. 170-75. (Ill.)

MECHANICAL ENGINEERING.

1. Boilers, Furnaces, Fuel.

Boiler Construction.—*Smoke-Preventing Fire-Door.* Description of a very simple and convenient method of automatically furnishing the additional air supply during the few minutes that it is usually required for preventing the formation of smoke in steam-boiler furnaces.—*Mechanical World*, Nov. 23rd, 1900, pp. 242, 243. (Ill. To be continued).

2. Compressed Air.

3. Engines and Motors.

Engines.—*Internal Combustion Engines.* The author, after drawing attention to the great development in the construction of these engines during recent years, and the successful manufacture of high-speed engines as well as of large engines developing high power, mentions those of the Diesel and the Banki type as specially suitable for automobile.—*Automotor Journal*, Nov., 1900, p. 59. (Ill.)

Engines.—*Internal Combustion Engines: The Diesel Internal Engine.* This is a fuller description in the same publication of the construction of this type of engine, of which three were shown at the Vincennes Annexe of the Paris Exhibition, one of which, built by the Maschinenfabrik Augsburg (Germany), is of 60 h.p., while the second was built by the French Diesel Company, and the third by the Société des Moteurs Otto.—*Automotor Journal*, Nov., 1900, pp. 65-67. (Ill.)

Steam Turbines.—*The De Laval Patent Steam Turbine.* Among many attempts to produce rotary engines, two only have met with real success recently, namely, those of Mr. Parsons, in England, and M. de Laval, in Sweden, and to the steam-turbine of the latter the present article is devoted. On the Continent the De Laval system has been very extensively applied, and hundreds of his motors are in constant operation.—*Mechanical Engineer*, Nov. 17th, 1900, pp. 689, 690. (Ill.)

Steam Automobiles.—*Steam Vehicles.* There were but few steam vehicles to be seen at the Paris Exhibition, but among these few those of the Gardner-Serpollet type were of real interest, and their improved forms are described in the present article. Among the portions treated in detail are the motor, which has the advantage of having no stuffing-boxes, the interconnected fuel and water feed-pumps, the safety valve between the boiler and the water reservoir, etc.—*Automotor Journal*, Nov., 1900, pp. 56-58. (Ill.)

Steam Power.—*The Design of Steam Power Plants. V. Specifications for Steam Engines.* The author discusses the points to be specified in inviting tenders for equipping steam plants, and lays stress upon the necessity of mentioning accessories, which are frequently overlooked.—*Engineering Record*, Oct. 18th, 1900, pp. 341-43.

4. Power and Transmission.

Lifts.—*The New Hydraulic Lifts for the 300 Mètres Tower.* Although the famous tower above-named, better known as the "Eiffel Tower," contained five lifts, permitting 25,000 ascensions to the first, 9,000 to the second, and 4,500 to the third daily, this year's exhibition was likely to increase the number of daily visitors considerably, and to meet this increase two new lifts were added, the one in the eastern foot of the structure, the other in the western foot, both manufactured by the Fives-Lille Company, and constructed with the object of making 8,000 trips in 10 hours each. Their construction is described in detail.—*Génie Civil*, Oct. 20th, pp. 441-44.

Pump Construction.—*The Pump of the Brewery at Ottakring.* By Mr. Forchheimer. Detailed description of the sinking of a pump which offered great difficulties. In order to sink the cast-iron pipes it became necessary to resort, in various places, to blasting. The building occupied eight years.—*Zeitschrift des Oesterreichischen Ingenieur und Architekten-Vereins*, Nov. 9th, 1900, pp. 693-97. (Ill.)

Turbines.—*The Swiss Turbines.* By Frank C. Perkins. The author describes various types of turbines of Swiss origin, shown at the Paris Exhibition, and points out that one firm alone in Switzerland has installed more than 3,000 turbines, aggregating more than 300,000 h.p., namely Escher, Wyss & Co., whose main works are at Zürich.—*Scientific American*, Nov. 24th, 1900, p. 324. (Ill.)

5. Machine Works, Shop and Foundry.

Machine Works.—*The Works of Ludwig Loewe & Co., Berlin.* Description of the above-named German works, which represent the latest development of the best American practice in manufacturing engineering, carried out more thoroughly than has ever yet been done, even in America, and with the system of interchangeability thoroughly applied in a manner which is equalled in Great Britain probably in one or two cases only. At the same time, while the articles manufactured are largely modelled on American lines, they are not mere

slavish imitations, but are modified to suit the more substantial ideas held in Europe in respect of scantlings and dimensions.—*Electrical Review* (London), Oct. 26th, 1900, pp. 668-71; Nov. 2nd, pp. 709, 710; Nov. 16th, pp. 788-90. (Ill. To be continued.)

6. Machine Tools.

Turret Lathes.—*Adjustable Automatic Feed Release for Turret Lathes.* Description of the device invented by Barden and Drake for the automatic release of the feeding device, and explanation of the action.—*American Machinist*, Oct. 25th, pp. 1021, 1022. (Ill.)

7. Refrigeration and Cold Storage.

Cold Storage.—*Refrigerating Machinery.* By S. Stewart & Co., Ltd., Glasgow. Description of machinery, both for marine and land purposes, including a marine type of carbonic anhydride refrigerating machine, a similar machine for land installations, a "Simplex" ice-making machine, and a machine of the same type as arranged for cold storage purposes.—*Steamship*, Dec., 1900, pp. 218, 219. (Ill.)

8. Miscellaneous.

Engineering Laboratories.—*The Imperial Physico-Technical Institution in Charlottenburg* By Henry S. Carhart. The author, who by the courtesy of the President of the above-named institution, was enabled to work there for several months, describes this famous laboratory, and, in this first instalment, gives an outline of its foundation and development.—*Electrical Review* (London), pp. 812-14. (To be continued.)

Engines.—250 *h.p. Gas Engine.* Description of an exceptionally large gas engine, recently completed by the Premier Gas Engine Company, designed for use with Mond producer gas, and having an indicated h.p. of 278.—*Engineer*, Nov. 16th, p. 493. (Ill.)

Steel Balls.—*A New System for the Manufacture of Steel Balls.* Few mechanics appear to know how steel balls, nowadays so frequently used for ball bearings of machinery, are made. The author of the article, after having pointed out that the manufacture has risen to almost ideal perfection, proceeds to describe what are probably the latest and most radical system and machinery for producing balls of any required degree of accuracy of form and size. The system referred to is that employed by the Steel Ball Company, of Chicago, and the machinery was designed by Mr. C. C. Hill, Vice-President and General Manager.—*American Machinist*, Nov. 1st, pp. 27-31.

Superheaters.—*Water Circulator and Steam Superheater* (*Makins' Patent*). Description of devices designed to secure economy in steam generation, manufactured by Messrs. Makins, Ltd., of Radcliffe. The saving effected by their use is given as from 10 to 30 per cent., and is ascribed to the employment of a cone system for both circulating the water in the boiler and for superheating the steam.—*Mechanical Progress*, Nov., 1900, pp. 29-32.

Technical Drawing.—*Apparatus for Drawing Arcs of Circles.* Description of an instrument for drawing arcs of large circles, consisting of a number of triangles connected by hinges, worked by an adjustable metal band.—*Génie Civil*, Nov. 3rd, 1900, p. 16. (Ill.)

MINING AND METALLURGY.

1. Coal and Coke.

Coal Mines.—*The Coal-Deposits of Victoria.* Digest of a lecture by Mr. James Stirling, at the Imperial Institute. The author very justly remarks that however great the demand for coal may become owing to the constant increase of manufactures, Great Britain, together "with her colonies," will have sufficient resources to meet it, and will remain independent of other countries, and then proceeds to describe the great coal deposits of Victoria.—*Iron and Coal Trades Review*, Nov. 23rd, 1900.

—— *Electrically-Driven Air-Compressors for the Working Faces of Collieries.* Description of a type of motor air-compressors, compact in style, and of relatively light weight, placed on the market by Messrs. Reavell & Co., of Ipswich.—*Iron and Coal Trades Review*, Nov. 30th, 1900. (Ill.)

2. Copper.

Copper.—*Influence of Copper in Retarding Corrosion of Soft Steel and Wrought Iron.* Abstract of a paper by Mr. F. H. Williams, read before the Engineers' Society of Western Pennsylvania, in which the author describes some tests made by him during the late spring of 1900 on the corrosion of iron and steel on a small scale, and the means most suitable for arresting it.—*Engineering Record*, Dec. 1st, 1900, p. 519.

3. Gold and Silver.

Gold Mining.—*The Cripple Creek District, Colorado. II. Mills and Samplers* By Dr. S. F. Hazlehurst. In the present instalment the author deals with the mills in the famous district and the samplers, of which there are five in active operation, while another one will be completed by Jan. 1st.—*Engineering and Mining Journal*, Nov. 10th, p. 545.

—— *The Cripple Creek District, Colorado. V. Some of the Mines.* By Dr. S. F. Hazlehurst. The author describes the plant of the "Vindicator Consolidated Gold Mining Company," which owns a tract of about 28 acres in all on the south-east side of Bull Hill, above the town of Goldfield.—*Engineering and Mining Journal*, Dec. 1st, 1900, pp. 635, 636. (Ill.)

4. Iron and Steel.

Iron.—*Iron and Phosphorus.* By M. Stead. (Continuation.) The present instalment describes the influence of carbon upon iron containing phosphorus during the process of welding and heating. (To be continued.)—*Engineering*, Nov. 2nd, 1900, pp. 579-84.

Iron Production.—*The Iron Ores of India.* A very interesting article showing that India possesses an almost inexhaustible wealth of iron ores, that the natives have from very remote times up to a recent date been known as skilful workers in iron, and produced a steel, the famous *wootz*, which was in high demand in many countries, being the only metal fitted for the manufacture of the finest swords, and that notwithstanding all this, the iron treasures of India remain undeveloped, for reasons which the author mentions.—*Colliery Guardian*, Nov. 16th, 1900, pp. 1,019-21.

5. Mining and Mining Methods.

6. Miscellaneous.

Mining Explosives.—*The Storage of Mining Explosives.* The author points out that with the high prices now current for explosives, colliery owners will do well to invest some of their capital in providing places for storage, and explains the conditions under which such an investment ought to be profitable.—*Colliery Guardian*, Nov 28th, 1900, pp. 1129, 1130.

Peat as Fuel.—*Peat and Compressed Peat Fuel.* By Philip R. Björling. This is the first instalment of a contribution on the subject dealing with the characteristic features of natural and compressed peat, and the various processes of cutting and compressing peat.—*Colliery Guardian*, Nov. 30th, pp. 1127, 1128.

MUNICIPAL ENGINEERING.

1. Gas Supply.

Incandescent Gas Light.—*Incandescent Gas Light in Factories and Workshops.* The central workshops of the *Deutsche Continental Gas-gesellschaft*, at Dessau, has been fitted with incandescent gas light, and each separate stall has its separate source of light. This was rendered possible only by suspending each lamp like a pendulum from an adjustable pipe arm, through which the gas passes into a rubber tube, and from there into the lamps. The cost of from 30 to 40 candle-power—assuming the prices of gas to be 0·17 of a shilling per cbm.—is about 0·12 of a shilling.—*Journ. Gasb. u. Wasserb.*, Nov. 3rd, 1900, pp. 355-58.

Gas Light.—*Theory of Incandescent Gas Light.* Abstract of a lecture by Dr. F. G. Love, of New York, in which the author after reviewing the gradual improvement in the incandescent mantles (from the date of Welsbach's demonstration of the possibility of obtaining from combustible gases greatly increased luminosity through the agency of the oxides of several rare metals to the present day) explains why the so-called "catalytic" theory has more supporters than any other, and there is but little reason for believing that any purely physical theory will suffice as an explanation.—*Journal of Gas Lighting*, Nov. 30th, 1900.

—— *Illuminating Gas by Sewage Sludge.* By X. Y. Z. The author proposes to utilize the marsh gas contained in sewage for illuminating purposes, and anticipates all objections to his scheme by pointing out that many proposals, which when realised proved to be eminently practical, were originally ridiculed and declared to be preposterous.—*Journal of Gas Lighting*, Nov. 6th, 1900, pp. 1140, 1141.

Gas Manufacture.—*Difficulties met with in the Construction of a Concrete Gasholder Tank.* Abstract of a paper by Mr. F. G. Cockey, Newport, Isle of Wight, in which the author very interestingly describes unforeseen difficulties occurring in the work above named. *Journal of Gas Lighting*, Nov. 20th, 1900, pp. 1270-73. (Ill.)

2. Sewerage.

Sewerage.—*Aldershot Camp Sewage Farm.* Description of the methods of utilising the sewage and of the results obtained, with a very careful discrimination between what is essential and incidental in the experiment. At all events the fact that 130 acres of barren sand have been made to bear six crops annually should suffice to induce all who are interested in such problems to read this very interesting contribution. *Engineering*, Nov. 30th, pp. 693-95. (Ill.)

3. Streets and Pavements.

Street Building.—*Progress of Work on the Rapid Transit Tunnel, New York.* The author describes the progress made so far, which gives reason to anticipate that this great enterprise will be completed within contract time.—*Scientific American*, Nov. 24th, 1900, p. 326. (Ill.)

4. Water Supply.

Pumping Stations.—*The Chestnut Hill Pumping Stations of the Metropolitan Waterworks, Boston. III.* Description of the pipe line, the travelling crane in the engine house, and the electric lighting plant.—*Engineering Record*, Oct. 27th, 1900, pp. 390, 391.

5. Miscellaneous.

NAVAL AND MILITARY ENGINEERING.

1. War Vessels.

Battleships.—*U.S. Battleship "Wisconsin" Exceeds 17 Knots Speed on Official Trial.*—Description of a fine battleship built at the Union Iron Works, San Francisco, being classed as a sea-going coast line battleship; its length on load water line is 386 ft., beam extreme 72 ft. 2½ in., gross tonnage 6,802 tons, displacement with two-thirds ammunition and stores on board, 11,525 tons, her designed speed was 16 knots with 10,000 i.h.p.—*Marine Engineering*, Nov., 1900, pp. 447, 448. (Ill.)

Cruisers.—*The New German Cruiser "Amazone."* Concise description of an armoured cruiser, having a length of 100 m., a width of 11·9 m., and at a draft of 5 m., having a displacement of 2,645 tons. The machines represent 6,600 h.p. and the speed is given as 20 knots.—*Engineer* Nov. 2nd, 1900, p. 435.

War Vessels.—*The Russian Warship "Nevik."* Description of the above-named vessel which, although being a ship of 3,000 tons, is practically a destroyer, or, as the author of the text remarks, might be called a destroyer-destroyer, and seems to fulfil a prediction by Admiral Colomb, according to which the destroyer was to be the war-ship of the future.—*Engineer*, Nov. 16th, 1900, pp. 486, 487. (Ill.)

2. Equipment.

3. Armour Plates, Guns and Ammunition.

Rifles.—*The Lee Straight-pull Magazine Rifle.* By E. G. Parkhurst. Description in detail of the component parts of the above-named rifle, which in 1894 was adopted by the United States Navy, and has since been greatly improved.—*American Machinist*, Nov. 22nd, 1900, pp. 27-32. (Ill.)

RAILWAY WORK.

1. Motive Power and Equipment.

Fire-Boxes.—*Smokeless Combustion in Locomotive Fire-boxes.* The author demonstrates that in order to obtain smokeless combustion there must be a sufficiently high temperature in the box with a sufficient admission of air, and describes the best methods for obtaining these conditions and the construction of the locomotive required for the purpose.—*Engineering News*, Oct. 18th, 1900, pp. 267, 268.

2. New Projects and Lines in Construction.

Railways.—*The Uganda Railway.* (Conclusion.) Refers to the stations on the line, workshops, rolling material, and the amount of traffic.—*Engineer*, Oct. 26th, 1900, p. 410. (Ill.)

Railroad Reconstruction.—*The Rebuilding of the Union Pacific.* The article deals with the important changes that are being effected in the permanent way of the above line, practically amounting to a reconstruction.—*Railway Age*, Nov. 2nd, 1900, p. 344.

3. Permanent Way and Fixtures.

Railway Bridges.—*Pneumatic Field Riveting in Railway Bridge Work.* Digest of a report regarding the great success obtained by various railways with riveting by compressed air.—*Engineering Record*, Oct. 27th, 1900, pp. 393, 394.

Railway Stations.—*Notable Railway Stations—Carlisle Citadel.* By H. V. French. Description of what the author calls one of the best known, best managed, and most important railway centres in the United Kingdom, *i.e.* the above-named station, which comprises an area of seven acres under glass roof, and still during the tourist season is found to be inadequate to deal comfortably with the amount of traffic, for Carlisle is the terminus of not fewer than seven railway systems, and the connecting link between the two kingdoms of two out of the three great trunk lines from London giving connection with Scotland.—*Railway Magazine*, Nov., 1900, pp. 386-94. (Ill.)

Tunnels.—*The Simplon Tunnel.* Detailed description of this important tunnel, containing a review of the work from the start to the present time, and an account of the various operations.—*Génie Civil*, Oct. 27th, 1900, pp. 461-469. (Ill.)

4. Transportation and Conducting.

Railway Trains.—*World-Famous Trains. VI. The Midland Scotch Express.* By W. Hartley Bracewell. Description of the character and performance of the train that leaves St. Pancras daily at 10.30 a.m. for Glasgow.—*Railway Magazine*, Nov., 1900, pp. 395-399. (Ill.)

5. Miscellaneous.

Boiler Explosion.—*The Explosion of a Locomotive at Westerfield.* A careful inquiry into the causes of the explosion above-named seems to show that the sequence of events was as follows: A rent was made in the side of

the fire-box, through which water rushed out; the pressure in the boiler being reduced, a portion of the water is flashed into steam; this flashing process being once started, it goes on until in the twinkling of an eye, a pressure is produced great enough to tear up the fire-box. It seems also that the simple screwing in of the lateral stay-bolts of the box does not suffice, and that the heads of the bolts ought to be annealed.—*Engineer*, Oct. 26th, 1900, p. 411. (Ill.)

Superheaters.—*A Controllable Superheater and Separator.* The pipes serving for superheating contain in their interior smaller copper tubes, through which the feed-water passes, so that it is simultaneously a feed-water heater. The manufacturers are the Cruse Controllable Superheater Company, Manchester.—*Engineer*, Nov. 2nd, 1900, p. 443. (Ill.)

Railway Cars.—*The Manufacture of Pressed Steel Cars.* By S. B. Ely. The author discusses the processes and means of handling pressed steel in the construction of an all steel railway car, such as have recently come into use, and are manufactured in considerable number by the Pressed Steel Car Company.—*Mechanical Engineer*, Nov. 10th, 1900, pp. 668-670.

STREET AND ELECTRIC RAILWAYS.

1. Trolley Lines.

Electric Tramways.—*Norwich Electric Tramways.* Description of the tramway lines which for the last two years have been in existence in the above-named ancient city, and of the 14 chains of additional double-track and 68 chains of single-track, the construction of which was authorised in 1898 and have now been successfully completed, although the tortuous streets and steep gradients offered considerable obstacles. The total length of track laid is over 26 miles, of which 5½ miles are double track, and the system is so constructed as to admit of extension.—*Tramway and Railway World*, Dec. 6th, 1900, p. 578-86. (Ill.)

Electric Traction.—*The Fond du Lac Street Railway and Light Company.* Description of an electric street railway line recently completed at Fond du Lac, Wisconsin, U.S.A., a small town of 16,000 inhabitants, but certain of a rapid increase in the near future, since the car shops of the Wisconsin Central Railway have been located there.—*Street Railway Journal*, Dec., 1900, pp. 981-83. (Ill.)

2. Surface Contact Lines.

3. Miscellaneous.

Electric Traction.—*Permanent Way for Electric Traction.* By H. Ross-Hooper. The author discusses the special requirements of track-materials for electric trams, *i.e.* rails, the concrete, paving, etc., and the question of maintenance.—*Tramway and Railway World*, Dec. 6th, pp. 586-88.

Street Railways.—*Proceedings of the International Street Railway Congress.* Digest of the reports read at the above-mentioned congress which was held in Paris from Sept. 10th to 18th, on which occasion above 500 persons interested in street-railway matters attended. The subjects discussed were Street Railway Fares, Results of the Application of Electricity to Street Railway Service, Advantages and Disadvantages of Standard and Narrow Gauge Track the Equipment of a Central Power Station, Systems of Power Distribution for Electric Railways, the Falk Joint, Traction by Accumulators, Heaters for Street Railway Cars, Method of Operating Secondary or Light Railways, Adoption of a Standard Rating for Tramway Motors, and Street Railway Brakes.—*Street Railway Journal*, Dec., 1900, pp. 984-96.

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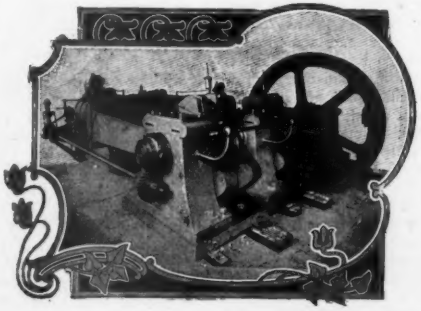
Errata.—In our November issue, on page 623, the articles abstracted under the headings "Foundry Management," "Machine Shops," and "Machine Tools—The Paris Exhibition, X.," have been erroneously credited to *American Machinery;* they were published in the *American Machinist.*



REVIEWS.

Naval Architecture. Fifth Edition. By W. H. White, K.C.B. London: John Murray.

The popularity of this manual and its usefulness as an aid to the officers of the Royal Navy, officers of the mercantile marine, yachtsmen, shipowners, and shipbuilders, is sufficiently in evidence by the fact that it is in its fifth edition. The manual in its original state contained almost all that was required for the designer's table and the draughtsman's board, for in that form it offered guidance in and explanation of the principles of naval architecture and of all the ordinary rules in use in ship design. But in this last edition the author has not confined himself to these subjects alone, for he has introduced to the notice of the reader the later views of naval architects on questions calling for solution at the present time.

In the days of Scott Russell and the *Great Eastern* it was held that a particular form of the ship resulted in its moving through water with least possible resistance. Scott Russell discovered that a particle of water passed an obstruction with least resistance when it moved in a path of the wave form, so he maintained that the bow of a ship should always be constructed of the wave form, to allow it to divide the water in its path with the least possible exertion of force. We know now that the wave form of a ship does not provide for everything, and that adopting it as a full solution of the problem necessitates the neglect of other considerable factors. Finality as regards the least resistance by constructing a ship of the wave form has not been obtained. Sir William takes this view, and introduces and explains to the reader the new views on the stream line theory brought forward by Mr. Froude and others. The first of the rules brought under discussion is that discovered by Colonel Beaufoy, which applies to the resistance of a plate moving through water in a direction perpendicular to its plane. The pull found necessary to make such a plate move with a speed of 10 ft. per second through water was found by experiment to be 112 lbs. per square foot of surface. This quantity (112 lbs.) was found afterwards, in the careful experiments made by Mr. Froude, to be a little too large, the correct figure being 109 lbs. But the establishment of a quantitative result of this kind gave a beginning to the settling of important results in the same direction. It was afterwards found that within certain limits the resistance to the motion of the plate varied as the square of its velocity through the water.

After this came the investigation into the resistance of a plate which moved through water in a direction oblique to its own plane. Here the author points out a cautionary rule to the reader against assuming too quickly that the resistance follows laws which a too readily adopted theory would suggest. He points out that formerly the resistance of an oblique plate was supposed to be equal to the direct resistance $\times$ ($\sin^3$ angle of obliquity), and later that it was supposed equal to the direct resistance $\times$ ($\sin^2$ angle of obliquity), and that after all Colonel Beaufoy found by towing a board at many different angles that its resistance did not follow any such simple rules. The rule which most nearly approaches in its results those actually found by experiment is that established by Lord Rayleigh, and that is in no sense so simple as $\sin^2$ or $\sin^3$ of the angle of obliquity.

Mr. Froude's results of the resistance of different surfaces are given, and also the three important rules which he established bearing on the subject, namely:—(1) The frictional resistance varies approximately as the square of the velocity when the area and condition of the surface is unchanged. (2) The length of the surface affects the mean resistance per square foot up to 50 ft. in length. (3) The frictional resistance caused by a slight difference in the apparent roughness of the surface was greatly increased. He also deduced the important quantitative result that the clean bottoms of ships when moving at a speed of 12·8 knots gave a frictional resistance of 1 lb. per square foot.

The latest and most beautiful experiments yet made in illustration of the motion of a ship through water are fully dealt with. It is shown that when the water has to divide and allow a body to go through, water particles of which it is composed flow in certain prescribed lines, and that these lines depend on the shape of the body. The author shows that the resistance to the motion of such a body is made up of three parts: (1) the frictional resistance due to the particles gliding over the rough sides; (2) eddy-making; (3) wave-making. The aim should therefore be to design a ship so that at its proper speed it shall make no waves and no eddies. The whole of this section dealing with the resistance of ships, with its explanations of modern theories and recent experiments, will be of the utmost service to the ship designer.

The author also points out the vagaries of the unit spoken of as the nominal horse-power. In the Naval directory one finds such terms, and the numerical value of the i.h.p. of the main engines of a ship under two conditions—forced draught and natural draught. The meaning of this is universally known, and, when it is given, we know at least the power of the engines which have been fitted in the ship. But it tells us nothing of its value as a propulsive agent. It tells us nothing of the percentage of waste which goes on between the engines and the real propulsive force which thrusts forward the ship through the water. Mr. Isherwood, in his experiments with H.M.S. *Greyhound*, found that at full power only 42 per per cent. of the i.h.p. was utilised in thrusting forward the ship—all the rest was wasted. On the other hand, when a steam launch 54 ft. in length had a speed of 7 knots the power utilised in thrusting it forward was 67 per cent. of the i.h.p. of the engines, and Mr. Yarrow found that a torpedo-boat 100 ft. in length, and at a speed of 15 knots, utilised 60 per cent. of the i.h.p. of the engines.

It was an excellent innovation when Mr. Denny introduced graded trials of vessels and recorded the speeds obtained with different horse-power

developed. It would be still better if the propulsion co-efficient were tabulated at the same time for the different speeds atttained and the powers developed. Under such conditions one could tell at a glance the work being expended on propulsion. The machinery may change, and does change, in efficiency for different powers developed, but a table such as that suggested, obtained from the results of the original trials of the machinery, would let us know what was going on under the different conditions.

The author traces the transition from the old type return tube boiler to the water-tube boiler in the navy, and rightly dwells on different methods engineers have adopted from time to time in accelerating evaporation. From the steam jets placed at the base of the funnel an acceleration of from 40 to 50 per cent. of combustion could be obtained. But the increase of combustion is not followed by a corresponding increase of evaporation, for the i.h.p. only rose some 15 per cent. M. Bertin's system of jets of compressed air placed at the base of the chimney gave a somewhat better result for an increase of 40 per cent. of the i.h.p. than that when natural draught was used, while the increase in coal consumption was only 20 per cent. per i.h.p. Into the question of the best type of water-tube boiler to be used in the navy the author does not enter.

The different methods of propulsion are gone fully into, and we are glad to notice that the system tried in the *Waterwitch* has been explained by giving the results of different trials with it. Hardly any system so manifestly theoretically wrong has had so fair a trial. The author gives the results of the trial of the system against the twin screw vessels *Viper* and *Vixen*, of similar dimensions, but not so well shaped in the after part. The *Viper* made 9·6 knots with 696 i.h.p. and a displacement of 1,180 tons, and the *Waterwitch* 9·3 knots with 760 i.h.p. and 1,160 tons displacement.

The great importance of having a tank for model experiments and the advantages gained from heat under the superintendence of Mr. R. E. Froude at the Naval Dockyard, Devonport, is fully set out in the book. One of the peculiarities of ship resistance is indicated in the author's table showing the speeds of different types of vessel with the corresponding horse power The conditions under which a torpedo boat makes 20 knots are the same as those under which an Atlantic steamer would make 44 knots. At high speeds small vessels like torpedo boats obtain advantages in lessened resistance, and large vessels would not come under those conditions until they had made a speed corresponding to their dimensions.

The book is of 731 pages, is fully illustrated, and has an ample index. It is suitable for anyone who wishes to study the subject, but pre-eminently will it be found useful by the ship designer. The manner in which the author leads the reader to adopt his views shows that he is practised in adapting his reasoning to all kinds of pupils.

Papers on Mechanical and Physical Subjects. By Osborne Reynolds, F.R.S., M.Inst.C.E., LL.D., Professor of Engineering in The Owens College. Reprinted from various transactions and journals. Vol. I. xv and 414 pages. Messrs. Clay and Sons, Cambridge University Press, 1900. Price 15*s.* net.

This reprint, containing, as it does, papers of great practical engineering interest in company with others of high value from the standpoint of scientific theory, may be expected to find a considerable circle of readers.

The author's series of seven papers dealing with the starting of screw steamers are in themselves of such importance that many marine engineers will be glad to have them accessible in a collected form. In the earlier of these papers he showed that the cause of racing in the propellers of screw steamers, which often occurs when the screw is only slightly immersed, lay in the admission of air to the propeller blades, and that the resistance encountered by the screw when travelling forward is independent of the depth of immersion provided there is no frothing.

In the later ones he describes his own investigations and also the further ones carried out in co-operation with a committee of the British Association, of which committee he was a member, to determine the reasons for the observed uncertainty of the steering of screw steamers when starting and stopping, which has been the cause of many accidents, owing to what was happening not being understood.

The following extract from the report of the committee in 1898 illustrates admiralty characteristics which we fear are still unchanged, although some of us faintly hope for better things *some day!*

"The importance of the effect of the reversed screw on the action of the rudder has been fully established, as well as the nature of its effect completely ascertained. *Also for two years the committee have urged the results of their work upon the attention of the Admiralty* and the various submarine boards, and although they regret that *as yet they have failed to obtain the general recognition of the facts brought to light which their vital importance demands*, they consider that this will surely follow, and that as a committe they can do no more than publish the reports of the trials, and the conclusions to which they have been led."

The italics are the reviewer's. He is not aware how far this complaint has since been remedied, but it certainly is a crying scandal that the ineptitude of Civil Service clerks should be allowed to put aside for two years the urgent recommendations of a committee consisting of James R. Napier, Sir William Thomson, W. Froude, J. T. Bottomley, and Osborne Reynolds.

Among other subjects of interest to practical engineers treated in these papers are the series of experiments on rolling-friction and various experimental investigations into points of steam-engine and steam-boiler practice; together with the short, but valuable contribution on the transmission of power by belts.

The most important paper, from the point of view of general scientific theory, is the classical one on "Certain Dimensional Properties of Matter

in the Gaseous State," dealing experimentally and mathematically with the phenomena of thermal transpiration and transpiration under pressure in gases, and with the phenomena of Crookes's radiometer.

The papers on refraction of sound by the atmosphere and on the internal cohesion of liquids are also well worth reading.

***Handbook of Electrotechnics* (*Handbuch der Elektrotechnik*).** Edited by Dr. C. Heinke. Vol. IV. Monophase and Polyphase Alternate Current Generators, by Dr. F. Niethammer (Oberingenieur). 1900; xvi. and 328 pages, fcap. 8vo, price 18 marks. S. Hirzel, Leipsic.

This is the first to appear of the eleven volumes of which the complete work is to consist, and if the remaining portions of the treatise fulfil the promise of the pioneer volume, we may be quite safe in predicting that very few electrical engineers who can read German, and have had their attention called to the work, will willingly be without at any rate those volumes which treat of the subjects in which they are mainly interested.

The present work opens with a brief but clear and instructive analysis of the various types of alternators, followed by nearly thirty pages of historical matter, and the only fault to be found with this portion of the book is that the hopes excited by the copious footnote references in the opening pages are doomed to such sudden extinction.

This is followed by four chapters devoted to the general electrical and magnetic consideration of alternators, which are models of lucid exposition and systematic arrangement. Running through these chapters is an admirable synopsis of the underlying mathematical theory. For those readers who desire to go further into the theory references are given to other works and to original papers, the latter being mostly German. Frequent reference is, however, made to Steinmetz's valuable treatise on "Alternating Current Phenomena." No references are made to the first volume of the Handbook itself, which is to deal with electric and magnetic theory, as this volume is not yet ready; but we presume that these will be inserted in the next edition, which will doubtless soon be called for.

Examples of the various types of E.M.F. curves are given from machines of well-known makers, and the kinds of curves most suitable under various circumstances are pointed out.

The different classes of winding are very completely but concisely treated, and illustrated by a large number of excellent diagrams. The discusssion of resonance phenomena and the consideration of the formulæ pertaining to them does not include any reference to the work of Oliver Heaviside, who investigated them mathematically long before they had been observed in practice. Hysteresis also is discussed without even the mention of Professor Ewing's name. The skin effect only receives brief notice, as was to be expected, as other portions of the work will be more appropriate for its full treatment. The author, however, finds room to give a formula of Brylinski's, without, however, any reference indicating where it is taken from; and Heaviside, Kelvin, and Rayleigh are not even mentioned in this connection. We trust the author will see his way to remedy these oversights in his next edition.

The principal methods of excitation, regulation, and compounding are clearly set forth, with the aid of numerous well-executed diagrams.

The chapter on the driving of alternators is a most valuable one, and the problems of parallel driving are very fully considered; but the only reference to Dr. Hopkinson's work is the mention of his name in a footnote.

The theoretical treatment generally, although not gone into at great length, is extremely well and clearly set forth, but the general impression produced in the mind of a reader fresh to the subject would be that the alternate current theory had mainly been developed by the American electrician Steinmetz and German contributors to the *Elektrotechnische Zeitschrift*, with some minor contributions by French electricians to be found in the volumes of *La Lumière Electrique*. Due credit is given to the practical work of English electricians, such as Ferranti, Mordey, and Esson, whose work has been described in the technical journals; and it is hard to account for the omission to give credit to Heaviside, Kelvin, Rayleigh, Hopkinson, and Ewing. In some cases it may be due to their papers having appeared only in purely scientific periodicals, such as the *Royal Society Transactions*, but others have been freely noticed in English technical journals.

A short, well-illustrated chapter on the mechanical construction of alternators concludes the general treatment of the subject, and this is followed by a very important series of chapters, occupying about a third of the whole volume, containing detailed descriptions with diagrams and working drawings of recent monophase and polyphase generators constructed by German, Austro-Hungarian, Swiss, and American firms respectively. A short final chapter on miscellaneous machines deals with a few examples only of the work of English, French, and other firms.

The volume is superbly illustrated, there being no less than 656 illustrations in all, mostly diagrams and working drawings, with a few half-tone blocks, which, however, in every case are of a kind to show constructional details, and there is not a single example of the catalogue type of illustration. Some half-dozen of the diagrams are somewhat roughly executed and attract attention on account of their incongruity with the exceptionally high standard otherwise maintained, though in many technical works they would pass muster without observation.

The working drawings and accompanying text, descriptive of the most recent continental practice, should commend the work to the attention of English engineers, even to those who may not have time to study the earlier portions.

There is a very complete index, which should be a *sine quâ non* in such a work as this, but it is so frequently omitted that it is only fair to call attention to it when present.

Manual of Electrical Undertakings, 1900—1901. Fifth year of publication by E. Garcke. Published at Donnington House, Norfolk Street, W.C. (xxxv. and 1210 pages), price 12s. 6d.

This is a work which should be in the hands of every one who is financially interested in any telegraph, telephone, electric supply, traction, manufacturing, or other electrical undertaking, to a sufficient extent to care for information about the affairs of the company or corporation by which it is carried on, the amount of their capital, the names of directors, their revenue, dividends paid, and many other details. It contains an alphabetical list of the directors and chief officials of all electrical undertakings now on the register, and another very useful feature is to be found in the two folding tabular diagrams, one of which shows graphically the average revenue per Board of Trade unit of electricity sold, and the cost of production at all the electric supply undertakings from which the information is obtainable; while the other gives an analysis of the accounts of electric supply undertakings owned by companies and corporations respectively, showing the profit made and the amounts set aside to provide for reserve fund and depreciation and for debenture and other interests.

The Chemistry of the Materials of Engineering. A Handbook for Engineering Students. By A. Humboldt Sexton, Professor of Metallurgy in the Glasgow and West of Scotland Technical College. 12mo, cloth, pp. 332; 34 engravings. Manchester: The Technical Publishing Co., Ltd., 1900.

The author, in his preface, states that this volume owes its existence to his desire to furnish engineering students with a suitable text-book to be used as the basis for lectures and as an introduction to the larger treatises on the subjects to which it refers. As the latter cover a very wide area indeed, the utmost conciseness in the treatment of every separate material was of course required, and the text had to be confined to a statement of the fundamental facts. The title of this text-book is somewhat narrower than the scope of the text, for Professor Sexton has not entirely confined himself to the chemistry of the materials included, but has in various cases, as for instance in the chapters on iron and steel, included the metallurgy, and in these and other chapters has referred even to micro-structure and purely physical properties. This statement does not imply any blame on our part, for a strict separation of chemistry and physical science has long since become untenable; but it may be questioned whether by doubling the size of the volume it might not have been rendered much more useful. At all events, it would have enabled the author to enlarge such chapters, for instance, as that on "The Foundry," sufficiently to render it of real value. The scanty measure of barely twelve pages is, as few will deny, somewhat too inadequate for the importance of the subject. The chapter on "Fuel" also, though by no means one of the shortest, might profitably be increased in compass, and the same holds good of half-a-dozen of the other sections. Considering, however, the size of the volume as it stands, the author has done remarkably well, and confined within the narrow limits selected by him a remarkable amount of information, especially as regards the chemistry and metallurgy of metals. There is, nevertheless, one defect that we are obliged to point out, in the hope that, if a second edition should be required, it may be mended—namely, the absence of an index. No book intended for reference—and such undoubtedly the present volume is—can be truly useful without this adjunct; and, above all, a volume in which the number of subjects treated is so large as it is in Professor Sexton's treatise, loses a considerable portion of its worth by this omission.

RECENT CATALOGUES.

General Trade Catalogue of W. Parkinson & Co. London: Cottage Lane Works, City Road; Birmingham; Bell Barn Road Works and Stour Street Works, King Edward's Road.

The new edition of the catalogue of this well-known firm of gas engineers is well illustrated and printed on art paper and solidly bound in stiff cover. It contains a concise description of a great variety of meters and accessory apparatus for gas works, together with flattering testimonials from competent judges, after reading which one is not astonished to find that Messrs. W. Parkinson & Co. who began their work at Cottage Lane, City Road, London, in 1816, in a works since greatly enlarged and improved, are now the owners of two large and well-equipped additional factories in Birmingham.

Illustrated General Catalogue of Messrs. Young and Marten. Caledonian Works, Stratford, London, England.

Among the many fine catalogues published of recent years by the leading firms of Great Britain, that of Messrs. Young and Marten is conspicuous both as regards comprehensiveness and general get-up. It is a complete compendium in two volumes, aggregating 880 pages royal 4to, and is half-bound in leather under very strong boards as cover. The type and the illustrations are clear, and the 54 pages printed in chromo-lithography are for the most part admirable. The contents comprise practically all articles required in the building, decorating, and practical engineering trades. Volume I. is devoted to chimney-pieces, tile-grates, registers, mantel-registers, and overmantels, interiors, dog-grates, tiles, panels, and hearths and accessories; self-settees, ranges and kitcheners, laundry and heating stoves, bath-boilers, and tile pavements; gas-fittings, gas-fitters' tools, sundries, gas pendants, pillars, lamps, brackets, globes and chandeliers; gas, cooking, and heating stoves; incandescent gas-fittings and accessories; white lead, oils, colours and varnishes, painters' and decorators' brushes and requisites. Volume II. comprises: plumbers' brasswork, lavatories, baths, closets, and goods for sanitary engineers; leaded cathedral lights, brilliant cut, embossed, bent, ornamental and

plain window-glass and casement ventilators; builders' ironmongery, tools, and machinery; rain-water and sanitary castings, manhole covers, wrought and cast-iron railings; stable fittings and heating apparatus; Staffordshire goods, drain-pipes, bricks, roofing slates and tiles, timbers, wood goods and joinery; paper-hangings and room mouldings. All these articles are clearly described and carefully indexed and cannot but be useful to everybody who is connected with the trades for which this fine catalogue has been compiled.

Patent Fast Grip Parallel Vice Catalogue. George Harrison & Co., Ure Bank Engine Works, Ripon, Yorks, sole makers; London Office: Morlais G. Jones, A.M.I.C.E., M.I.Mech.E., Delahay Street, Westminster, S.W.

This is a new edition of the "Vice Catalogue," published by the above-mentioned makers, and contains a full description of their form of parallel vice, the different parts of which are now manufactured in batches to standard gauges, so that a large stock can be kept ready for urgent delivery. These vices have obtained a high reputation throughout the United Kingdom, and have been supplied to Her Majesty's Royal Dockyards at Chatham, Deptford, Keyham and Portsmouth, as well as to most of the great railway companies and the prominent engineers and shipbuilders of the country, their advantages being the parallel opening of the jaws, which is a desideratum for all high-class work, their easy working and rapid opening and closing, the arrangement of the "fast grip" handle which is out of the workman's way for light work, but instantly available for heavy work, and the fact that only a single casting each for the back and front jaws is required, and there are, therefore, no bolts to shear off or to shake loose.

The Simplex Steel Conduit Co., Ltd., New Supplementary List. The Simplex Steel Co., Ltd., Coventry Street, Birmingham. London Offices and Stores: Mansion House Chambers, 20, Bucklersbury, London.

This new list contains some recent improvements in the steel conduit system of the above-named firm, among them a screwed brazed conduit of heavy gauge and screwed fittings for use in places where a watertight system is insisted upon, such as breweries for instance; split bends and T pieces; a new type of box, enamelled iron cased, switch and fuse distributing boards; pendant fittings, with porcelain bridge with connection terminals; removable porcelain interiors and connection bars for use with the standard junction boxes of the Company, and various other devices. The Simplex Steel Conduit Co.'s products have been awarded a Gold Medal during the Paris Exhibition last year, and are constantly growing in favour owing to their efficiency and very moderate cost.

The British Westinghouse Electric and Manufacturing Co., Ltd.. Circulars. Westinghouse Building, Norfolk Street, Strand, London, W.C.

Among the recently published circulars we note No. 1028, which is devoted to rotary converters, which have attained the highest importance in connection with electric traction; No. 1032, describing the Westinghouse No. 56 Tramway Motor, which possesses numerous features of merit; and No. 1034, describing a line of direct-current engine-type generators, designed and constructed particularly for the purpose of supplying power to motors, operating machine tools, cranes, elevators, ventilators, pumps, rolls, drills, cutting machines, etc., in factories, mills, and mines. These generators are designed to furnish current at 250 volts, and, as the usual practice is to employ 220-volt motors for the purposes mentioned, this allows 30 volts drop of potential in the line. The use of a 250-volt generator also permits the operation of both arc and incandescent lamps from the motor circuits. Each of these three catalogues is a proof of the fact that the British Westinghouse Co. keeps fully abreast of the times and promptly meets every requirement arising in the course of our constantly increasing experience in the application of electric energy.

Schoen Pressed Steel Freight Cars. By the Pittsburg Steel Car Co. Sole agents, The Transportation Development Co., 6, Clements Lane, Lombard Street, London, E.C.

The pamphlet issued under the above title contains a lucid description of the Schoen Pressed Steel Freight Cars accompanied by a number of fine photographic reproductions and demonstrates the advantages of this new type of railroad car, which though it has come into general use only quite recently has had a phenomenal success on account of the economies realised through its employment.

Illustrated Catalogue of Steam Engines and Agricultural Machinery, manufactured by Marshall, Sons & Co., Ltd. Britannia Iron Works and Trent Works, Gainsborough. London Offices, Show Rooms and Stores: Marshall's Buildings, 79, Farringdon Road, E.C.

This catalogue, described as No. 207, gives an illustrated account of the several classes of the firm's manufactures which are specially adapted to the requirements of agriculturists, which, however, gives but an inadequate idea of the enormous amount of work performed by this distinguished firm, which of engines alone has turned out more than 31,500, and produces machinery of almost any kind of description.

Illustrated Catalogue of Steam Engines, Boilers, and other Machinery manufactured by Marshall, Sons & Co., Ltd., Britannia Iron Works and Trent Works, Gainsborough. London Offices, Show Rooms, and Stores: Marshall's Buildings, 79, Farringdon Road, E.C. Indian Branch Offices and Godowns: 99, Clive Street, and Strand, Calcutta.

This catalogue, described as No. 215, which is devoted to machinery for industrial purposes, together with the one described above, gives a somewhat fairer idea of the wide field covered by the firm, which embraces fixed engines, independent vertical engines, compound engines of the stationary, semi-portable, and portable kind, winding and hauling engines, portable steam engines in great variety, patent automatic expansion

gear, engines for burning straw, reeds, maize, and cotton stalks, traction engines, steam road rollers, grinding and sawing machinery, etc., for which Messrs. Marshall, Sons & Co. have received the highest awards in most of the international exhibitions in which they participated. Among their recent trade circulars may be mentioned also that marked No. 225, dealing specially with a horizontal fixed engine. Class "K," represented by an illustration of a right-hand engine, fitted with Hartnell's automatic expansion gear, and a horizontal fixed condensing engine also fitted with this gear, representing Class "K.D.," while the circular marked No. 228 contains a concise account of a horizontal fixed engine. Class "L.," illustrated by a single cylinder left-hand engine, fitted with the patent gear, and other engines of the horizontal kind, *i.e.* condensing engines, Class "L.H.," non-condensing coupled compound engines, Class "L.C.," tandem engines, Class "L.T.," condensing coupled compound, Class "L.H.C." and tandem class "L.H.T." Among the illustrations is one of a class "L.H." engine, and another of a coupled compound engine, while there is a section of Marshall's Patent Trip Gear, accompanied by explanatory text.

The "Campbell" Gas Engine. Sole makers, the Campbell Gas Engine Co, Ltd., Halifax, England. London Office: 114, Tooley Street, E.C.

The new catalogue of the company is well printed and illustrated. It contains a description of the standard types of this well-known engine, and calls attention also to the "Campbell" Oil Engine, for which the owners claim that it has a larger sale than any other make in the world. The company has been awarded a gold medal in recognition of its merit at the recent Paris Exhibition.

Illustrated Catalogue of Dairy Appliances. Manufactured by Vipan and Headly, Dairy Engineers, Leicester, England.

This is a revised issue of of a neatly illustrated catalogue containing a very complete list of milk-floats and milk-carriages, together with every article of outfit, as well as complete sets of dairy equipment and all apparatus required for the successful production of butter and cheese. Two gold medals at the late Paris Exhibition and a silver medal awarded by the Warwickshire Agricultural Society last year, testify to the high-class character of Vipan and Headly's products.

Mather and Platt, Ltd., Enclosed Motors. Salford Iron Works, Manchester.

The type of motor described in the above trade circular has been especially designed to meet a want which has been experienced for a motor suitable for all conditions of work, and so protected as to comply with the most stringent Fire Office rules. It can be, if desired, hermetically enclosed so as to be entirely protected from water or gas, and can work in the most exposed situations without danger of being damaged or causing damage. The firm produces these motors in various sizes, designed for pressures ranging from 100 to 500 volts, and arranged to run at several rates of speeds. The circular here referred to gives a concise description and lists of data and prices as well as a price list of accessories. To this is added a separate price list of motor starting switches and a table of motor speed regulations stating cost

Paris Universal Exhibition, 1900. Mather and Platt, Ltd., Salford Iron Works, Manchester.

Under the above title Messrs. Mather and Platt have published a very neat little "souvenir," containing, in six pages of text and illustrations, a concise description of their exhibits at Paris last year, *i.e.* the combined electrical plant in which one of their generators of 250 volts and 1,400 ampères is coupled with an engine built by Messrs. Galloways of Manchester; a compound vertical marine type engine and dynamo combined; a multipolar generator; an 800-h.p. combined plant consisting of a triple-expansion engine and two two-phase generators running at 270 rev. per minute; a triple-expansion engine and direct-current generator, indicating 850 h.p. at 110 rev. per minute; an electrical conveyer for light loads, and a specimen of the well-known "Manchester Dynamo," together with specimens of their enclosed motors. The illustrations are delicately reproduced, and the small pamphlet is very neat in appearance.

Complete Cyanide Plants, Supplement No. 3. The Cyanide Plant Supply Co., 56, New Broad Street, London, E.C.

The above is the title of an interesting catalogue containing photographs of the largest cyanide plants in Australasia and in India, for both of which the Cyanide Plant Supply Co. furnished vats and accessories. Since its inauguration this company has had the experience of receiving among its orders a large portion that were for complete plants as specified in its catalogue of 1898, and during the past three years it has shipped a very large number of plants of all sizes from the 500-ton-a-month plant up to the largest plants in existence. This industrial concern appears to take a special pride in being thoroughly up-to-date and makes the fullest use of valuable suggestions constantly received from the engineers in charge of cyanide plants in various parts of the world, many of whom were trained by the company's technical adviser. The supplementary catalogue here referred to contains specifications of steel and white pine tailings plants, of a complete clean-up plant, of steel double treatment tailings plants, of slimes plants, and of cheap wooden tailings plants. As regards these latter, which are often ordered as a preliminary installation, to be afterwards replaced by more expensive plants, the company has made arrangements for having the vats, which are made of seasoned redwood, together with the accessories, shipped directly from California, where this wood grows, which considerably reduces the time for filling an order. It may be of interest to mining engineers to learn that the Cyanide Plant Supply Co. is ready to deliver a plant in ten days.

Silicate Cotton (Slag Wool) for Insulation, Cold Storage, Deafening, and Fireproofing. D. Anderson & Son, Ltd

Address: Lagan Works, Belfast, and 812, Old Ford Road, Bow, London. E.

The catalogue bearing the above title, and showing on its cover a "red hand" as trade mark, gives a concise description of the substance known as British-made silicate cotton, or "slag wool," of which one ton contains 2,000 square feet one inch thick, when applied thin, and of which, if packed as in ordinary practice for *insulating* cold store, one ton will equal about 187 cubic feet. It is nearly free from lime, practically indestructible, vermin-proof, fireproof, and an excellent non-conductor, *i.e.* heat, cold, and sound-proof. Its price is very moderate, and, considering its efficiency, it appears to be the cheapest insulating material in the market. Messrs. Anderson & Son, Ltd., in their catalogue give a concise description of its use for cold storage insulation, for rendering buildings fire and sound-proof, and for covering boilers and pipes. Towards the end of the catalogue a long list of cold stores, warships, etc., is given, in which silicate cotton has been successfully employed, and to this is added a list of prices at which the firm sells this substance and material manufactured from it.

Luxurious "Swift" Cycles, 1901. The Swift Cycle Co., Ltd., Cheylesmore Works, Coventry; London address: 15 & 16, Holborn Viaduct, E.C.

This new catalogue contains an introduction summarising the gradual development of the "Swift" cycle, a statement of the terms on which the manufacturers are dealing with the "trade," the conditions of "guarantee," and a statement of the restrictions under which the term "agent" is to be used, etc. This is followed by an illustrated description of the various parts and special features of their cycles, a short account of the different types and their characteristics, and, finally, a description of the company's tandems, tricycles, and of the "Swift" Motor Cycle and the "Swift" Motor-Quadricycle, which is a very neat and compact auto-motor sold at the price of 110 guineas cash. There is also a short statement regarding the terms of a gradual payment system resembling that on which the "Enclyclopædia Britannica" was supplied by the *Times* and the *Daily Mail*.

British Steam Specialties, Ltd., Catalogue No. 1. Communications to be addressed to Fleet Street, Leicester.

In this catalogue the reason for the foundation of the company is stated to be the fact that specialties in the heating trade have not heretofore received sufficient recognition, and the announcement is made that the company will henceforth place before the public what it considers the best modern appliances of this kind. For this purpose, it is said, has the new company acquired the right to manufacture in England the Kieley & Müller appliances, which have met with considerable success in the United States and Canada, and of other similar goods. The bulk of the catalogue is devoted to a description of various articles patented by Kieley and Müller, accompanied by well-executed illustrations.

Notes on Electric Tramways. Wm. E. Kenway, A.I.Mech.E., 17, Burlington Chambers, New Street, Birmingham.

This is the title of a pamphlet describing what the author considers to be the advantages of the "Victor" Bond and the "Victor" Joint for electric tramway rails.

W. J. Baker's Patents. Baker's Patent Appliances Co., Ltd., Engineers, 13, Huntriss Row, Scarborough.

This catalogue deals with "The Softening and Purification of Water for Boilers and Manufacturing Purposes," with "Oil Separators and Steam Driers," and with "Appliances for Economising Exhaust Steam and Saving Fuel" under W. J. Baker's patents. Among the apparatus illustrated and described is the "Alliance" Water Softener, the "Standard" Oil Separator, for the complete separation of oil and lubricating grease from exhaust steam (a "Standard" Oil Separator is shown attached to a triple-expansion engine of 1,200 i.h.p. surface condensing), an oil pump for discharging grease from oil separator, and the "Standard" Steam Drier. To this are added price lists giving the cost of the various devices according to the dimensions required.

Twentieth Century Catalogue. Lumby, Son & Wood, Ltd., Boilers for all purposes. West Grove Boiler and Safe Works, Halifax, England.

This catalogue, published by the above-named firm of manufacturers of wrought-iron and steel-welded and riveted boilers for heating apparatus, on the low pressure hot water and low pressure steam systems, etc., is a very artistic production, typographically, and does great credit to the enterprise of those responsible for the publication. Messrs. Lumby, Son & Wood, Ltd., are in possession of the only gold medal ever awarded at any International Exhibition for wrought welded boilers, when in competition, and of numerous other medals in gold and silver which were awarded them for their boilers and safes wherever exhibited. The numerous half-tone illustrations of the various types of boilers, etc., are in every case accompanied by carefully elaborated tables of dimensions and price lists, and a full index increases the usefulness of this attractive little work of reference. Special mention, perhaps, ought to be made among the many new designs and improvements of the so-called Patent "Pioneer" Boiler, which was placed upon the market three and a half years ago, and has had a pronounced success, being, it is said, the most perfect boiler ever constructed, its peculiarity consisting in the fact that by means of an outside casing the inside as well as the outside surfaces are used as heating surfaces. By the addition of tubes in the fire-box and grop-tubes in the flue, an increased surface is obtained without the outside size of the boiler having had to be altered. As the outside casing, moreover, is easily taken off, the boiler can be passed without difficulty through a narrow doorway. Messrs. Lumby, Son & Wood, Ltd., have recently erected new works near Halifax in order to cope with the ever-increasing demand for these products, and the number of workmen employed there will be not far from 500 within the near future.